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NATIONAL DAM SAFETY PROGRAM. DEVOE LAKE DAM (NJ00384). RARITAN --ETC(U)
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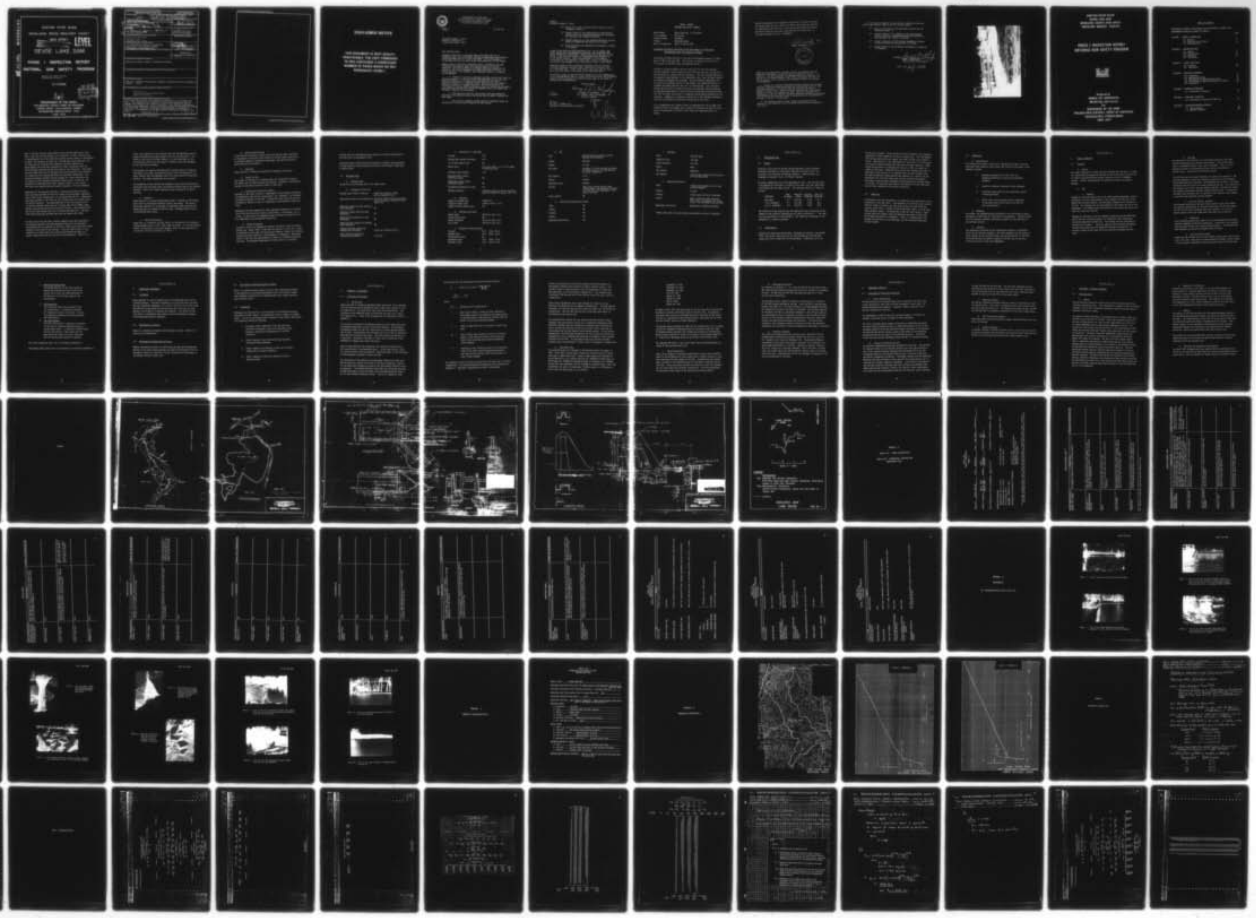

RARITAN RIVER BASIN

MANALAPAN BROOK, MIDDLESEX COUNTY

NEW JERSEY

LEVEL

DEVOE LAKE DAM

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

Approved for public release;
distribution unlimited

NJ 00384

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE - 2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

JUNE 1978

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National Dam Safety Program Phase I
Devoe Lake Dam, N.J.

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-D

31 JUL 1978

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Devoe Lake Dam in Middlesex County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given on the first three pages of the report.

Based on visual inspection, available records, calculations and past operational performance, Devoe Lake Dam is judged to be in poor condition. The dam's spillway is considered seriously inadequate as 8 percent of the Probable Maximum Flood (PMF) would overtop the dam. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. Studies for providing additional spillway capacity and concurrent stability analysis of existing and modified dam sections should be under taken and completed by the owner within one year from the date of approval of this report. Remedial actions resulting from these studies should be initiated in calendar year 1979. Due to the potential for overtopping of the dam, detailed emergency operation, warning and evacuation plans should be developed and placed in operation within two months from the date of approval of this report.

b. The inoperable left low level outlet sluice gate should be restored to full operation within six months from the date of approval of this report.

c. The following remedial actions should be completed within one calendar year from the date of approval of this report:

NAPEN-D
Honorable Brendan T. Byrne

(1) Repair of the left concrete spillway wing wall and the embankment behind it.

(2) General repairs to the remainder of the deteriorated concrete surfaces, downstream abutment area protection and downstream left channel protection.

(3) Seepage coming out of both abutment embankment sections should be channalized and monitored for volume.

(4) Upgrade Operation and Maintenance procedures by issuing O & M Manual.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Frank Thompson, Jr. of the Fourth District. Under the provisions of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, thirty days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia, 22171 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

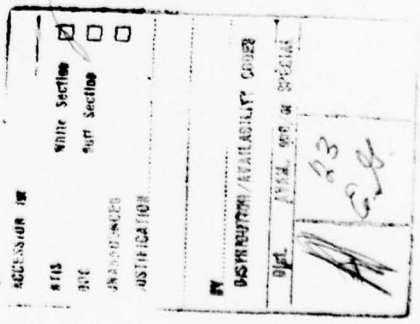
Sincerely yours,

Harry V. Dutchyshyn

1 Incl
As stated

HARRY V. DUTCHYSHYN
Colonel, Corps of Engineers
District Engineer

Cy furn:
Mr. Dirk C. Hofman, P.E.
Department of Environmental Protection



PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Devoe Lake Dam, I.D. NJ 00384
State Located:	New Jersey
County Located:	Middlesex
Stream:	Manalapan Brook
Date of Inspection:	May 4, 5 and 8, 1978

Assessment of General Condition of Dam with Respect to Safety and Recommended Action with Degree of Urgency

The safety of Devoe Lake Dam is considered questionable because it cannot pass the PMF or one half PMF. The spillway is capable of passing only 7.5 percent of the PMF without overtopping the dam.

The dam is in deteriorated condition along the left spillway wingwall, with the wingwall itself partly missing at the upstream end, and severely spalled along its exposed surfaces elsewhere. The left abutment embankment is severely eroded adjacent to the downstream side of the spillway wingwall and should be regraded and protected. The left abutment embankment next to the missing upstream portion of the wingwall has eroded and should be regraded and protected after the wall is reconstructed. The left downstream channel bank has eroded in the past and had been poorly protected by ungraded dumped material, which should be graded and protected by stone. The left low level outlet gate is inoperable and should be restored to full operation. Seepage can be observed coming out of both abutment embankment sections, and should be channelized and monitored for volume.

It is recommended that remedial action be completed for all of these deficiencies within one calendar year, except for restoring the left low level outlet to operational condition, which should be completed within six months.

Further investigation for augmenting the spillway capacity should be completed within one year, and concurrently, data should be acquired for determining the stability of the concrete spillway under present operating conditions and under projected operating conditions if spillway discharge capacity is augmented.

Robert Gershowitz, P.E.

Based on visual inspection, available records, calculations and past operational performance, Devoe Lake Dam is judged to be in poor condition. The dam's spillway is considered seriously inadequate as 8 percent of the Probable Maximum Flood (PMF) would overtop the dam. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

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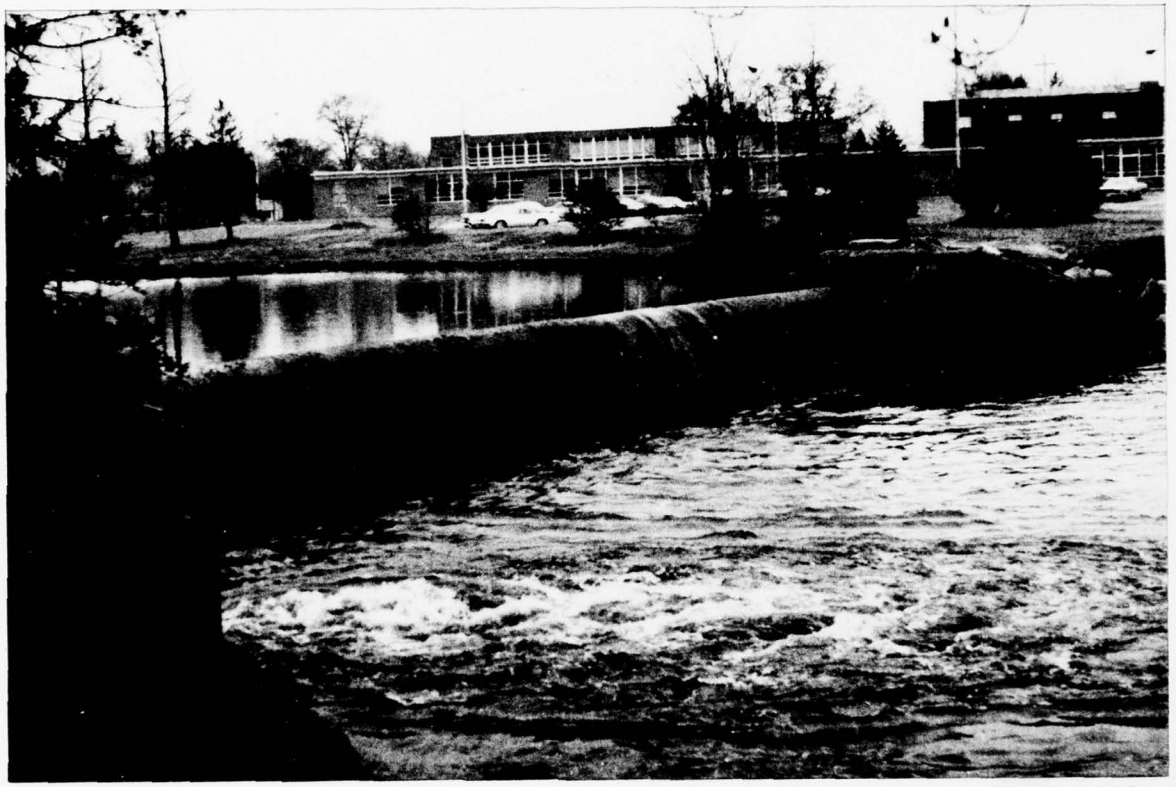
(4) Upgrade Operation and Maintenance procedures by issuing an O & M Manual.

APPROVED: Harry V. Dutchyshyn

HARRY V. DUTCHYSHYN
Colonel, Corps of Engineers

DATE: 31 July 1978



May 1978

DEVOE LAKE DAM

RARITAN RIVER BASIN
DEVOE LAKE DAM
MIDDLESEX COUNTY, NEW JERSEY
INVENTORY NUMBER: NJ00384

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared by
HARRIS-ECI ASSOCIATES
Woodbridge, New Jersey
for
DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA
JUNE 1978

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ASSESSMENT OF GENERAL CONDITION OF DAM WITH RESPECT TO SAFETY AND RECOMMENDED ACTION WITH DEGREE OF URGENCY

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

DEVOE LAKE DAM, I.D. NJ 00384

SECTION 1

1. PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August 1972 authorizes the Secretary of the Army, through the Corps of Engineers to initiate a national program of dam inspections. Inspection for Devoe Lake Dam were carried out under Contract DACW61-77-C-0100 to the Department of the Army, Philadelphia District, Corps of Engineers by the engineering firm of Harris-ECI Associates of Woodbridge, New Jersey.

b. Purpose of Inspection

The purpose of the inspection and evaluation is to identify conditions which threaten the public safety and thus permit the correction of the conditions in a timely manner by the owners. The National Inventory of Dams will be updated by the data acquired during the inspection.

1.2 Description of Project

a. General Description of Dam and Appurtenances

Devoe Lake Dam consists of a central ungated concrete spillway between massive earth embankment abutment sections. The dam impounds the waters of Manalapan Brook to create Lake Devoe. The central concrete spillway is a gravity structure resting on timber piles. The length of the spill-

way is 110 feet, and the total height of the spillway monolith is 14.4 feet. The crest of the spillway is at elevation 17.6 MSL, and the crest is approximately 10.4 feet above the existing stream channel as constructed in 1933. The concrete spillway has a 20-foot deep steel sheet pile cut off installed at the heel which continues into each abutment for approximately 35 to 40 feet according to scaled information from contract drawings uncovered during this phase of the inspection. The extent that the sheet pile cut-off continues into each abutment is not definitely dimensioned and cannot beverified from available information. Construction drawings indicate 30-foot lengths of a steel sheet pile cut-off curtain in the abutments extending along the axis of the dam. An estimate of 4,450 square feet does, however, appear in the records. The top of the sheet piling was visually observed in the left abutment.

Downstream of the concrete spillway, a reinforced concrete stilling basin has been provided for the full length of the spillway, approximately 11-foot long, terminating in a pile supported end sill. Weep holes have been provided in the floor of the stilling basin to relieve excessive uplift pressures. The downstream end of the stilling basin sill is further protected from scour by a 10-foot deep row of timber sheet piling, used during construction and left in place. The concrete spillway has an ogee shaped crest and is divided into monoliths. The monolith joints have been provided with keys and copper water stops.

At each side of the spillway, sloping wingwalls have been provided in the upstream approach side and downstream along the stilling basin. The wingwalls are constructed to include a 3-foot square low level outlet conduit on each side of the spillway. Each low level conduit is controlled by a 3-foot square iron sluice gate operated by means of a control stand mounted at the dam axis on each abutment. There is no

trash rack provision on the upstream end, and the downstream end discharges through the spillway wingwall into the stilling basin. The invert of the low level outlet conduit is at the same level as the stilling basin floor, and the conduit is normally entirely submerged by the prevailing tailwater.

The abutments are massive and apparently had been rebuilt or added to from parts of an older structure existing at the site previously. Records indicate that the abutments were to be constructed of impervious material. No zoning information was uncovered.

The foundation of the spillway and abutments consists of sand and gravel overlaying fine grey water sand, according to boring logs on the contract drawings. There is no formal approach channel leading to the dam's spillway.

b. Location

Devoe Lake Dam is located on Manalapan Brook, a tributary of the Matchaponix Brook at Spotswood, Middlesex County, New Jersey. The nearest downstream community is the Borough of Spotswood itself and there are urbanized areas all around the dam and lake. Manalapan Brook is part of the Raritan River Basin.

c. Size Classification

Devoe Lake is classified as being "Small" on the basis of its reservoir storage volume, which is less than 1,000 acre feet. It is classified as "Small" on the basis of its total heights, which is less than 40 feet. The overall size classification is "Small".

d. Hazard Classification

In the National Inventory of Dams, Devoe Lake Dam has been classified as High Hazard on the basis that failure of the dam would cause excessive property damage to residences downstream, and could potentially cause more than a few deaths.

e. Ownership

Devoe Lake Dam is owned by the Borough of Spotswood, New Jersey.

f. Purpose of Dam

The purpose of the dam is to impound water for recreational purposes. The normal uses are small boating and fishing. Swimming is discouraged because of unsuitable bacterial counts in the water.

g. Design and Construction History

Drawings in the files of the N.J. Department of Environmental Protection are dated March 1933 and are signed by Mr. W.E. Buchanan, Civil Engineer and Borough Engineer at the time. Construction took place during 1933 according to records in the N.J. Department of Environmental Protection files.

Apparently the left abutment has been regraded by addition of a parking lot in the area since the original construction. The abutment, as it stands, is more massive in appearance than indicated on records of the N.J. Department of Environmental Protection.

H. Normal Procedures

The dam is used as an impounding reservoir to create a lake for recreational uses. Water levels in the lake are kept at or near crest level by operation of the right low level outlet whenever waters are released from the upstream reservoir, Lake Manalapan, at Jamesburg. High water levels in the lake are objectionable to owners of residences adjoining the lake. The Spotswood Department of Public Works is in routine

contact with the Lake Manalapan dam operators to permit regulation of the lake level to acceptable limits.

There have been no complaints from downstream residents during periods of high stream or dam discharges according to the Borough's Department of Public Works.

1.3 Pertinent Data

a. Drainage Areas

At dam site, the drainage area is 41 square miles.

b. Discharge at Dam site

Maximum known flood at damsite:	1,650 cfs on May 30, 1968; pool at elevation 19.9
Warm water outlet at pool elevation:	Low level outlet capacity estimated at 236 cfs each at reservoir crest level 17.6
Diversion tunnel low pool outlet at pool elevation:	NA
Diversion tunnel outlet at pool elevation:	NA
Gated spillway capacity at pool elevation:	NA
Gated spillway capacity at maximum pool elevation:	NA
Ungated spillway capacity at maximum pool elevation:	2,300 cfs (elevation 20.7)
Total spillway capacity at maximum pool elevation:	2,300 cfs

c. Elevation (ft. above MSL)

Top dam:	20.7
Maximum pool-design surcharge:	20.7
Full flood control pool:	NA
Normal pool:	17.6 plus approx. 0 to 1.0 ft.depth of overflow water
Spillway crest (gated):	17.6
Upstream portal invert diversion tunnel:	NA
Downstream portal invert diversion tunnel:	NA
Streambed at centerline of dam:	5.2
Maximum tailwater:	Tailwater rating curve not available; normal tailwater at approx. elev. 9.8

d. Reservoir

Length of maximum pool:	4,500 feet
Length of normal pool:	3,000 ft (Elev. 17.6)
Length of flood control pool:	NA

e. Storage (acre-feet)

Normal pool:	230 AF at elev. 17.6
Flood control pool:	NA
Design surcharge:	355 AF at elev. 20.2
Top of dam:	355 AF at elev. 20.7

f. Reservoir Surface (acres)

Top dam:	62.0	(Elev. 20.7)
Maximum pool:	62.0	(Elev. 20.7)
Flood-control pool:	NA	
Recreation pool:	19.0	(Elev. 17.6)
Spillway crest:	19.0	(Elev. 17.6)

g. Dam

Type:	Concrete gravity spillway section between earth abutments
Length:	290 feet
Height:	15 feet
Top width:	Variable, 11.5 feet minimum according to NJ-DEP records, but more massive on visual inspection
Side slopes:	2 on 1
Zoning:	Unknown
Impervious core:	Unknown
Cut-off	Steel sheet piling 30-foot deep lateral extent not known, but estimated at 30-35 feet into embankment from edge of spillway
Grout curtain:	NA

h. Diversion and Regulating Tunnel

Type:	NA
Length:	NA
Closure:	NA
Access:	NA
Regulating facilities:	NA

i. Spillway

Type:	Concrete ogee
Length of weir:	110 feet
Crest elevation:	17.6 MSL
Gates:	None
U/S channel:	Reservoir
D/S channel:	11-foot long concrete stilling basin, full spillway width

j. Regulating Outlets *

Type:	3-foot square conduit, one in each spillway wingwall
Length:	14 feet
Closure:	3-foot square vertical slide gate
Access:	Gate is normally under reservoir water level, no features for isolation & dry maintenance are provided
Regulating facilities:	Geared hoist, manually operated

* Note: Only right low level outlet was operable on date of inspection

SECTION 2

2. ENGINEERING DATA

2.1 Design

Drawings in the files of the New Jersey Department of Environmental Protection (NJ-DEP) are dated March 1933 and are signed by Mr. W.E. Buchanan, Civil Engineer and Borough Engineer. These drawings are appended as Drawings 1 to 4, in "Plates" section.

No design computation are in the Department's files. The spillway capacity approved by the NJ-DEP is listed as 42.6 cubic feet per square mile of drainage area (41 square miles). The spillway capacity is listed as follows:

Condition	Head on Crest	Reservoir Level	Spillway Discharge	Cubic ft./ Sq.mi.DA
Dam Awash	3.1	20.7 MSL	2,320	57.1
1-ft. freeboard	2.1	19.7 MSL	1,250	30.2
0.5 ft. freeboard	2.6	20.2 MSL	1,750	42.6

The stability of the concrete weir has apparently been calculated and the summary of the stability computations are shown on Drawing 3. The loading case description is not available. The stability information is not adequate for a safety assessment.

2.2 Construction

Construction took place during 1933. According to records in the NJ-DEP files, the 15-ton capacity piles for the spillway and stilling were jetted the first 12 feet and driven thereafter. Penetration of 12 to

24 feet were recorded. At the easterly or right abutment, the inspectors complained of poor compaction at time of construction. The left embankment during construction was judged "too light" having a top width of 6 feet. Additional fill was requested for a top width of 11.5 feet and the face was ordered covered with swamp sod for water tightness. Apparently too, no letter of acceptance was sent up to 1944, as noted in a report of that date. Comparing the existing left abutment with what is described in the reports, it is apparent that the left abutment area has been extensively redeveloped by the addition of a parking lot and additional fill with the result that the left abutment now appears very massive and no proper embankment configuration with defined slopes is visible. No notations were made on the condition of the right abutment to allow comparison with current conditions.

2.3 Operation

No documents have been uncovered as to operating rules pertaining to the regulation of the lake level. The operation is run-of-the river, and an effort is made to maintain the lake level within one foot above the spillway crest level, in order to avoid high water complaints from lake shore property owners. The operation of the low level outlet is coordinated with the releases from Lake Manalapan upstream of Devoe Lake Dam on Manalapan Brook, at Jamesburg. There is a communication link between the operators at Lake Manalapan and the Spotswood Department of Public Works.

2.4 Evaluation

a. Availability

The availability of data is only fair considering the age of the dam. Additional data needed to fully assess the stability and safety of the abutment includes:

1. Engineering properties of the soils and foundation materials of both earth embankment abutments.

2. Location of phreatic surfaces at both abutments.

3. Tailwater rating curve for the downstream channel of Manalapan Brook.

4. Uplift data in the spillway section downstream of the sheet pile cut-off and at the start of the stilling basin.

b. Adequacy

At present, the engineering data available is not sufficient to draw a conclusion on the safety or stability of the abutments. Sufficient data is also lacking to perform a definitive analysis of the stability of the spillway section.

c. Validity

The information available on the construction drawings is apparently valid for the concrete spillway. The earth abutments are not shown in cross section on the available plans, but the description in the files of the NJ-DEP does not match in general with what can be currently visually observed on the left embankment.

SECTION 3

3. VISUAL INSPECTION

3.1 Findings

a. General

The visual inspection of Devoe Lake Dam revealed that the dam is in need of a rehabilitation program to restore its low level outlet capacity and to restore some deteriorated concrete surfaces as well as abutment erosion. Further investigations are needed to monitor the abutment seepage.

b. Dam

1. Seepage

Seepage was observed coming out of the right abutment embankment section, beginning at a point approximately 8 feet landward from the end of the downstream spillway wingwall, and continuing landward for a distance of 12 feet. The leakage zone was approximately 8 feet below the top of the embankment. The leakage rate was estimated at one gallon per minute and there was some local erosion.

Seepage was observed in the left abutment coming out at the downstream end of the left spillway wingwall and continuing 6 feet downstream along the downstream channel bank. The seepage rate was estimated at one gallon per minute. There was general erosion on both abutments, and the area behind the left downstream spillway training wall is severely eroded and has been partially protected by dumped concrete slabs.

2. Spillway

The concrete of the spillway is in serviceable condition with some surface roughening due to spillway water action. The spillway ogee crest is acceptably smooth, level and in alignment. There is no observable distress at the monolith joints with no misalignment or offsets noted. No structural cracking was noted.

The stilling basin was under tailwater and could not be observed. The spillway wingwalls on the left abutment, upstream side were severely deteriorated and partly missing. Reinforcement was uncovered. The downstream end and top of wall was badly eroded and spalled. The right spillway wingwall was in fair and serviceable condition, although the surface has eroded at the normal spillway overflow wetting zone. The concrete upstream right reservoir wall is spalled at the interface joint between it and the right upstream spillway wingwall.

3. Low Level Outlet Concrete

The concrete forming the low level outlet conduit slide gate chamber was severely deteriorated at the top of dam level and the cover slabs were not in place, fully covering the access opening. The low level outlet conduit itself was under water and could not be observed.

4. Foundation

Fine to medium grained sands underlie the left embankment and spillway structure (Magothy and Raritan formations). Exploration logs indicate clay and gravel lenses occur below ground elevation. Fill mantles the right abutment and overlies permeable sand and gravel.

5. Low Level Outlet Gates

Devoe Lake Dam contains two low level conduit outlet gates, one on each side of the dam. Both gates are manufactured by Chapman, 36-inch square in size, manually operated by reduction geared crank and rising stem.

The gate on the left hand side of the dam is inoperable according to the owners. The gate on the right hand side is functional and was opened fully on the day prior to the inspection in order to draw the reservoir down to the elevation of the spillway crest.

The gate leaf has a moderate amount of corrosion, however, it is not enough to affect the strength or operation of the gate. The stem and reduction gearing is in good condition. Both operating stands have missing gear cover plates.

c. Appurtenant Structures

There are no appurtenant structures on this dam.

d. Reservoir

The reservoir rim is flat to very gently sloping with many properties adjoining the lake shore. Sedimentation is a continuing problem. The reservoir was dredged in 1972 to create extra depth along the right shore line. The dam has not been overtopped, according to the Spotswood Department of Public Works, and U.S.G.S. gaging records.

e. Downstream Channel

The downstream channel of Manalapan Brook is well defined, and tree lined along the right bank. The left bank has been eroded in the first 300-foot reach below the dam and additional medium grained sand has been dumped but not graded to provide extra bank protection. There is no channel obstructions in the immediate downstream reach. One large building is located on the immediate downstream right bank and other residences are further downstream.

3.2 Evaluation

The visual inspection can be evaluated as follows:

1. Abutment Seepage:
   The volume of seepage on both abutments is very low and is of no immediate concern; however, a program of monitoring this leakage should be initiated and the seepage channelized for volume estimation. Seepage should be checked on a monthly basis and logged by the owner's personnel.

2. Concrete Surface Deterioration, Spalling and Missing Concrete:
   Missing concrete should be replaced and deteriorated surfaces repaired by plain or epoxy concrete overlays in the spillway wingwalls and on the low level outlet gate shaft exterior surfaces. Proper fitting cover slabs or metal cover plates for the gate shafts should be provided.

3. Eroded Areas in Back of Spillway Wingwalls:
   The erosion in these areas can affect the safety of the dam and the area behind the left spillway wingwall should be regraded and protected by large size stone riprap on suitably graded bedding. Stone protection should be added behind the right downstream spillway for the same reason although observed erosion and sloughing are not serious on this side. The area of embankment at the missing portion of the left upstream spillway wingwall should be regraded after the spillway wall has been rebuilt, and protected by stone riprap.

4. Downstream Channel Bank:
   The dumped material on this bank should be graded and protected by large sized riprap stones for at least 100 feet downstream of the dam axis for increased safety of the dam abutment.

5. Stilling Basin:
   This basin has never been inspected since its installation. It should be unwatered or inspected by divers in the wet. The end sill should be examined for concrete erosion and undercutting.

6. Low Level Outlets:
   The left sluice gate is inoperative resulting in the loss of valuable discharge capacity during storm events. It should be rehabilitated and put into service. Both right and left gate operating stands are partly vandalized and all missing parts should be replaced.

The visual inspection check list is included in Appendix A.

Photographs taken during the site inspection are included in Appendix B.

SECTION 4

4. OPERATIONAL PROCEDURES

4.1 Procedures

Devoe Lake Dam is used to impound waters from Manalapan Brook for recreation purposes. The dam is operated as a run-of-the-river facility. The only regulation attempted is to restrain the lake level from rising more than 12 inches above the spillway crest by use of the low level outlets, one of which is currently not operable. The control of the lake level is coordinated with releases from Lake Manalapan upstream on the Manalapan Brook at Jamesburg.

4.2 Maintenance of the Dam

There is no regularly scheduled dam maintenance program. Repairs are made on an as-needed basis.

4.3 Maintenance of Operating Facilities

Regular maintenance consists of lubricating the gate hoist mechanisms. Records of low level outlet openings are kept and forwarded to the U.S. Geological Survey for inclusion in their calibration of discharges at the gaging station on Devoe Lake.

4.4 Description of Warning System in Effect

There is no formal warning system set up to alert downstream residents or the operators at the downstream Duhernal Dam as to possible danger from accidental misoperation or impending high water stages caused by heavy rainfall events.

4.5 Evaluation

Maintenance of the facility is in the hands of the Spotswood Borough Department of Public Works. The procedures are on a simple, as-needed basis. In view of the greater public interest in dam safety, the following procedures should be initiated.

1. An annual visual inspection of the dam utilizing the Corps of Engineers check list conducted by the Borough's engineering representative or the DPW supervisor.

2. Formal logging of low level outlet gate openings, lubrication and maintenance.

3. Formal logging of maintenance at dam, be it repairs, inspection or reservoir dredging.

4. Formal logging of high water complaints and responding actions.

SECTION 5

5. HYDRAULIC / HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

Devoe Lake Dam is located on Manapalan Brook about half a mile upstream from the confluence with Matchaponix Brook, where they combine to form the South River. The South River flows into the Raritan River. The drainage area of Manapalan Brook at the Devoe Lake dam site is about 41.0 square miles. A map of the drainage area is presented in Plate 1, Appendix D.

The principal tributaries of Manapalan Brook are Still House Brook and an unnamed stream whose source is near West Freehold. The headwaters of Manapalan Brook are near the intersection of State Secondary Routes 537 and 524. The headlands are relatively low hills, none of them being above 300 feet from mean sea level. The lower portion of the basin is a low plain. Drainage in the basin is poor, and is reflected in the abundance of swampy areas within the basin.

Land is used primarily for residential and industrial purpose along the lower portion of the Manapalan Brook. In the upper portion, land is used for pasture land and orchards. Manalapan Brook is also impounded at Lake Manalapan upstream of Devoe Lake Dam.

The evaluation of the hydraulic and hydrologic features of Devoe Lake Dam was based on criteria set forth in the Corps' guidelines, Section 4.3 and additional guidance provided by the Philadelphia District Corps of Engineers. The Probable Maximum Flood (PMF) was calculated from the Probable Maximum Precipitation (PMP) using Hydrometeorological Report No. 33 with standard reduction factors. The Clark Method was used

for deriving the unit hydrograph with the following equations:

$$t_c = 8.29\ (1.0 + 0.311)^{-1.28} \left(\frac{D.A}{S}\right)^{0.28}$$

$$\frac{R}{t_c + R} = 0.65$$

where:

D.A = drainage area in square miles.

S = water course slope, in feet per mile, defined as the average slope of the watercourse between points 10 and 85 percent of the distance upstream from the runoff site to the watershed boundary.

I = index of impervious cover in percent of total land area.

t_c = time in hours from the end of a burst of rainfall excess to the inflection point on the recession limb of the resulting direct runoff hydrograph (Clark method).

R = discharge at the inflection point on the recession limb of the direct runoff hydrograph divided by the slope of the recession limb at that point, in hours (Clark method).

The computed t_c and R for Devoe Lake Dam are 5.20 hours and 9.71 hours respectively. The hydrologic/hydraulic computations are presented in Appendix D - Hydrologic Computations and HEC-1 computations.

Initial infiltration loss rates were applied using SCS procedures to the Probable Maximum Storm rainfall to obtain rainfall excess. The rainfall excess is then applied to the unit hydrograph to obtain the PMF hydrograph, utilizing computer program HEC-1. The computed peak discharge of PMF and one half of the PMF are 34,615 cfs and 17,307 cfs respectively.

These inflow hydrographs were routed through the reservoir by the Modified Puls Method utilizing computer program HEC-1. The peak outflow discharges for the PMF and one half of PMF are 32,285 cfs and 16,108 cfs respectively. Both the PMF and one half of the PMF would result in overtopping of the present dam.

The stage-outflow relation for the spillway and the reservoir stage-frequency data were based on the U.S.G.S. quadrangle topographic maps. Reservoir storage capacity included for surcharge level exceeding the top of dam and the spillway rating curve at pool levels above top of dam assumed that the dam remains intact during routing. In the routing computations, the discharge through the low level outlet facilities was excluded due to its insignificant magnitude as compared to the spillway discharge and the PMF. The spillway rating curve and the reservoir capacity curve are presented in Plates 2 and 3 of Appendix D respectively.

b. Experience Data

The recorded history of flooding in the Manalapan Brook area began in 1932. Since then, several major floods have occurred and minor floods have been a common occurrence. Based on peak stages and discharges of the following U.S. G.S. gaging stations: No. 01405500 on South River at Old Bridge, No. 01405400 on Manalapan Brook at Spotswood, No. 01406000 on Deep Run near Browntown, and No. 01465000 on Tennents Brook also near Brownstown; the dates of eight major flooding events, as reflected by one or more of these gages, are as follows:

September 9, 1934
September 21, 1938
September 15, 1944
July 19, 1945
August 21, 1948
August 15, 1955
May 29, 1968
August 28, 1971

On August 27-28, 1971, New Jersey was hit by Hurricane Doria causing the President to declare the State a natural disaster area. An extensive high water mark survey was conducted jointly by the State of New Jersey and the U.S. Geological Survey following Doria; these data are on files with the NJ-DEP, Division of Water Resources.

The maximum known discharge of 1,650 cfs was recorded for U.S.G.S. gaging station No. 01405400 on Manalapan Brook at Spotswood on May 30, 1968. The adopted design discharge for floodway delineation on the Manalapan Brook at Devoe Lake Dam is 2,160 cfs according to Flood Hazard Report No. 8 - South River, Manalapan Brook by the NJ-DEP, dated October 1972.

The computed PMF value is 19.5 times larger than the maximum known discharge at the Lake Devoe dam site.

c. Visual Observation

There is no evidence of excessive sedimentation due to recent developments in the drainage basin which could cause a sudden increase in sediment load which may pose danger to the dam. Sedimentation has however been a problem in the shallower areas of Lake Devoe, affecting recreation uses. Scour and severe erosion were observed in the left abutment due to storm runoff and tailwater fluctuations. No riprap protection was observed on the slopes of the downstream discharge channel.

d. Overtopping Potential

As indicated in Section 5.1 - a., both the PMF and the one half of the PMF, when routed through the Devoe Lake reservoir, result in overtopping the dam. The PMF and one half PMF overtopped the dam by 6.9 feet and 3.8 feet respectively.

The spillway is only capable of passing a flood equal to 7.5 percent of the PMF without overtopping the dam. Since the PMF is the Spillway Design Flood (SDF) for this dam according to the Recommended Guidelines for Inspection of Dams by the Corps of Engineers, the spillway capacity of the Devoe Lake Dam is considered inadequate. The spillway capacity was determined by Corps of Engineers screening criteria and the actual capacity of the spillway should be determined by the owner using more precise and sophisticated methods and procedures. The conclusions reached in this inspection report are based on present day hydrologic conditions and the effect of future development on hydrology is uncertain.

e. Reservoir Drawdown

The reservoir drawdown below the spillway crest, elevation 17.60 is accomplished by permitting discharge through the twin 3 ft. by 3 ft. R.C. conduits with invert at elevation 9.75. The minimum tailwater corresponds to the top of the conduit, elevation 12.75 resulting in a total head differential of 4.85 feet. Assuming a constant inflow of 82 cfs (2 cfs/sq.mi.), the total drawdown time is 44 hours, at which point the inflow equals the outflow and the reservoir pool is at elevation 13.48 feet. Assuming zero inflow, the drawdown to elevation 12.75 can be accomplished in 20 hours.

SECTION 6

6. STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The dam structure has remained intact over its 45-year life span since it was constructed, and it has not been overtopped in that time. The highest recorded flood produced a reservoir level of elevation 19.9 giving a freeboard of 0.8 foot.

The embankments in both of the left spillway wingwall is eroded, and presents a possible source of danger if left unattended.

The left low level outlet conduit slide gate is inoperable and should be rehabilitated immediately since it adds approximately 155 cfs to the discharge capacity of the dam and would reduce the danger of overtopping and possible dam failure during a severe flood event of the magnitude observed during the life span of the existing structure. The effect of the low level outlet discharges during the PMF is considered minimal.

b. Design and Construction Data

No stability computations have been uncovered for checking. The position of resultant forces on the concrete spillway weir have been plotted on one of the contract drawings obtained from the NJ-DEP files, but the assumptions made for the various loading cases is unknown, especially the uplift assumptions considered. A tailwater rating curve for Manalapan Brook has not been uncovered in this phase of the investigation, but is required for a proper stability assessment. A preliminary assessment of the spillway stability indicates that the spillway could probably meet modern overturning stability criteria for reservoir levels experienced up to date, but has questionable stability for reservoir levels required

to pass the PMF and one half PMF. The wood pile foundation of the spillway has only vertically driven piles, and their safe capacity to resist horizontal loads at the high reservoir level required to pass the PMF or one half of the PMF is also questionable.

c. Operating Records

The dam has withstood a maximum flood of 1,650 cfs resulting in a pool of elevation 19.9. This level is compared to the crest elevation 17.6 and top of dam elevation 20.7. The required dam height to pass the PMF and one half PMF is estimated at elevation 27.6 and 24.5 respectively.

d. Post Construction Changes

There have been no post construction changes that would affect the stability of the dam.

e. Seismic Stability

In general, projects located in Seismic Zone 0, 1 and 2 may be assumed to present no hazard from earthquake, provided the static stability conditions are satisfactory and conventional safety margins exist.

SECTION 7

7. ASSESSMENT / REMEDIAL MEASURES

7.1 Dam Assessment

a. Safety

The dam had been inspected visually and a review has been made of the available engineering data. This assessment is subject to the limitations inherent in the visual inspection procedures stipulated by the Corps of Engineers for Phase I Report.

The safety of Devoe Lake Dam is in question since it cannot safely pass the PMF or even one half of the PMF. These two discharges would overtop the existing dam by 6.9 and 3.8 feet respectively and could lead to severe embankment erosion and possible embankment failure. The stability of the central concrete spillway is also questionable at PMF levels and requires additional further data acquisition to fully assess its stability. Currently observable embankment erosion behind the deteriorated left spillway training wall is considered a source of danger and should be corrected. The left low level conduit outlet gate is inoperable and should be rehabilitated and put into service. Leakage sources in both abutments are currently of low volume but must be monitored and recorded to assure continuing stability. The left downstream channel bank has suffered some erosion damage in the past and should be more properly protected than the current emergency type measures employed. Further investigation for augmenting the spillway capacity should be undertaken, and concurrently data should be acquired for determining the stability of the concrete spillway under present conditions, and under projected operating conditions if the spillway capacity is to be augmented.

b. Adequacy of Information

Information uncovered in this phase is not considered adequate to assess stability. Required additional information related to the stability of the concrete spillway section at PMF or one half PMF discharges includes a tailwater rating curve, and an investigation of uplift pressures under the spillway. The adequacy of the timber pile foundation to resist lateral loadings at PMF and half PMF levels is also not determinable without further detailed analysis.

c. Urgency

The repairs to the left spillway wall and eroded embankment behind it are considered of intermediate urgency and should be completed within one year. The rehabilitation of the left low level outlet sluice gate is considered urgent and should be completed within 6 months. The general repairs to the remainder of deteriorated concrete surfaces, downstream abutment area protection, and downstream left channel protection, should be accomplished within one calendar year.

The studies for providing additional spillway capacity and concurrent stability analysis of existing and modified dam sections should be completed within one calendar year.

d. Necessity for Additional Investigation

In view of the inadequate spillway capacity and the questionable stability of the concrete spillway under the existing and proposed maximum water levels, the investigation of safety should be continued further.

7.2 Remedial Measures

a. Alternatives

Alternatives for increasing the spillway capacity are as follows:

1. Raising the abutment of the dam and reservoir rim to allow a higher head on the ungated spillway and thus permit higher discharges. The drawbacks to this scheme would be possible inundation of lake shore communities during extreme storm events, although the risks of high water stages is more or less the same as with the present dam configuration.

   A one-foot rise in dam height would increase the volume discharged by approximately 60 percent.

   The stilling basin downstream of the dam would have to be checked for hydraulic sufficiency.

2. Creation of an auxiliary spillway adjacent to the dam on one abutment to increase the discharge capacity.

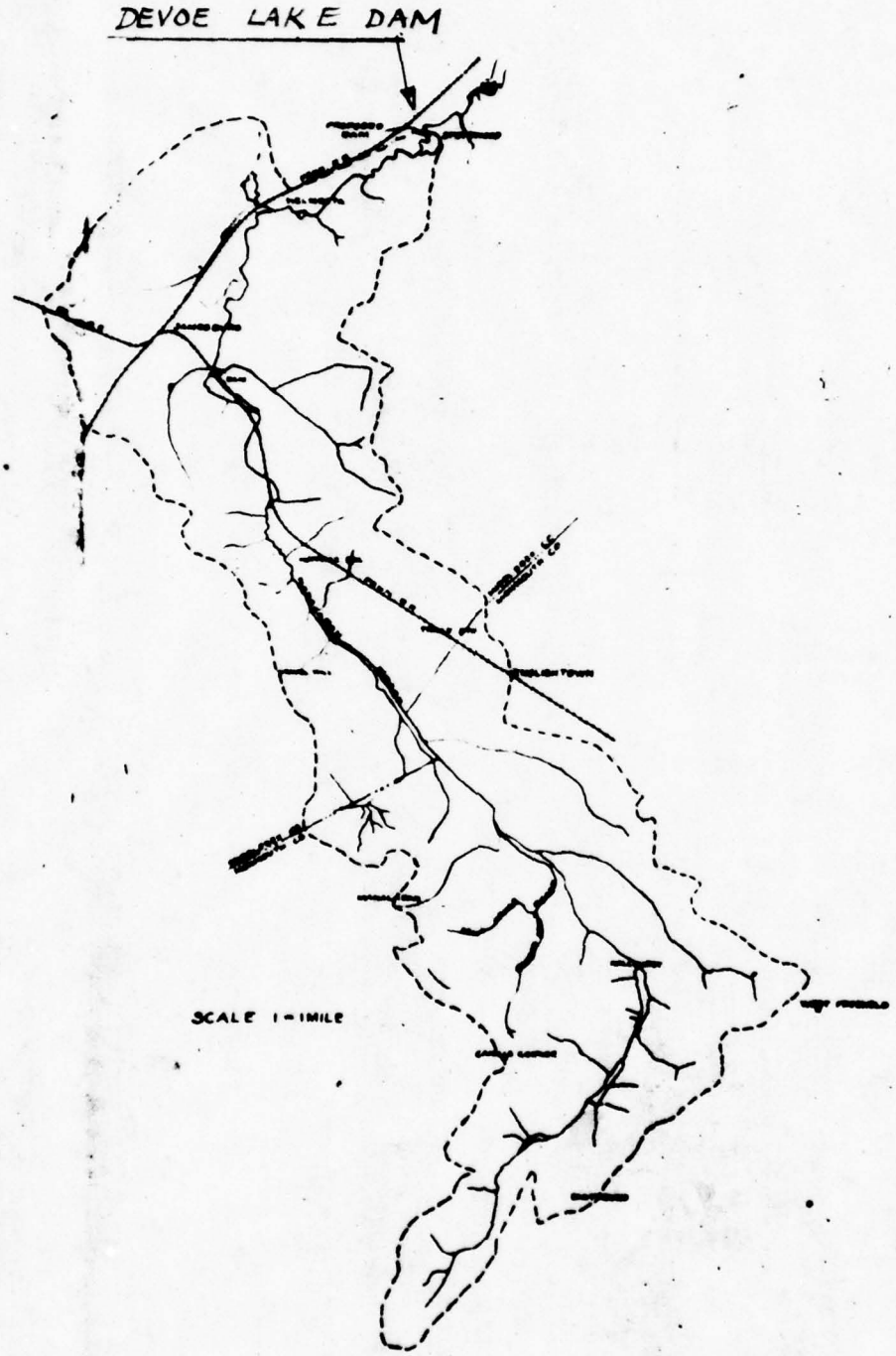
3. Creation of a new service spillway, possibly gated, adjacent to the present spillway, using the present spillway as an emergency facility.

4. A combination of all three alternatives mentioned above.

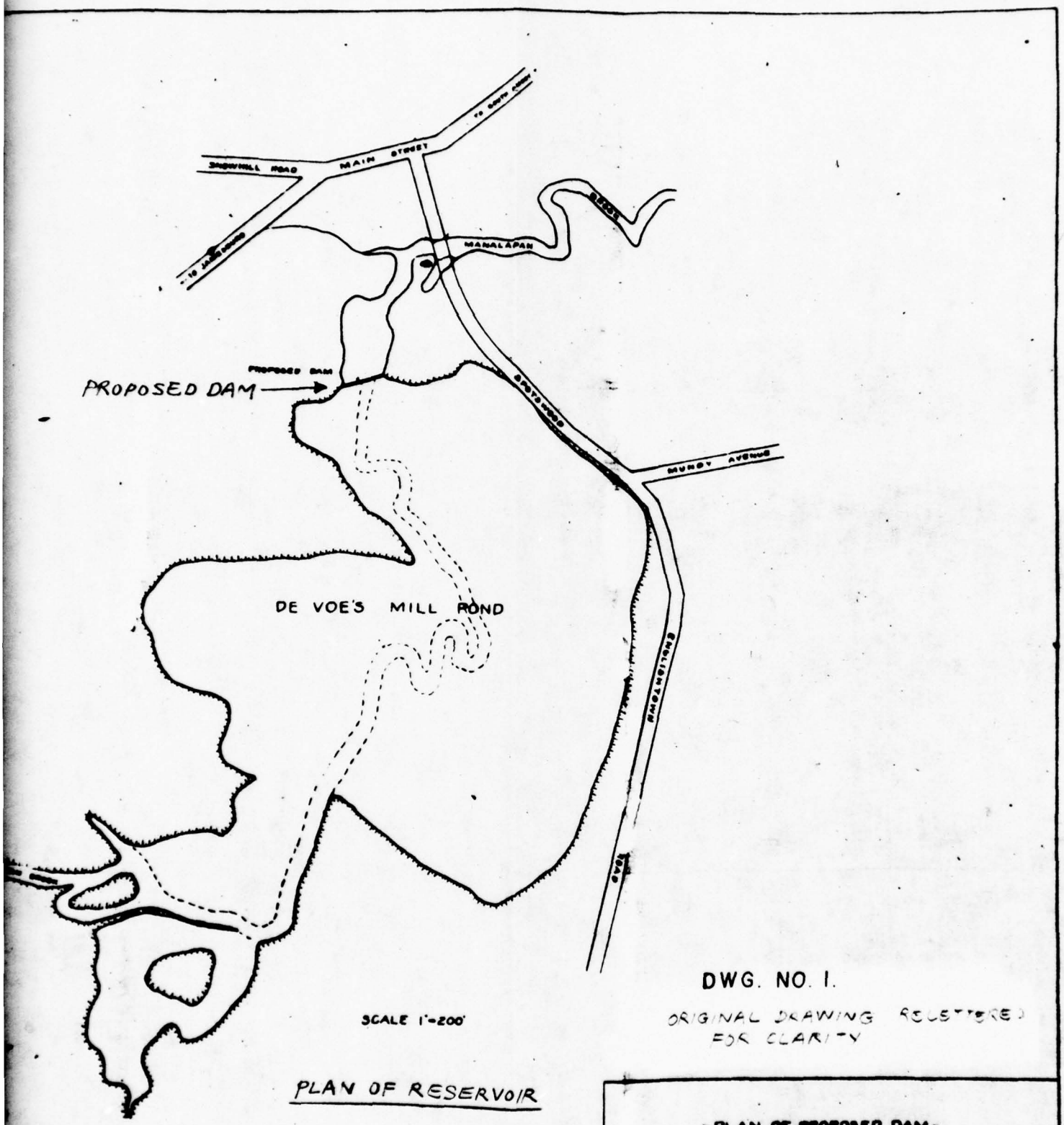
b. O & M Procedures

The owner should upgrade his O & M procedures by issuing a manual and check list for recommended procedures. An annual inspection should be carried out, using a format similar to the visual inspection check list used by the Corps of Engineers in Appendix A. The inspection report should be kept in the Borough's DPW files. Inspection and maintenance visits should be logged and documented. The Borough should make a concerted effort to assemble a record set of as-built drawings of the dam and all other available data relating to the design and construction of the dam from available sources. A communication channel should be set up with the Borough Police and the downstream Duhernal Dam operators in case of dam's misfunction, impending high water stages or accidents.

PLATES



DRAINAGE AREA



DWG. NO. I.

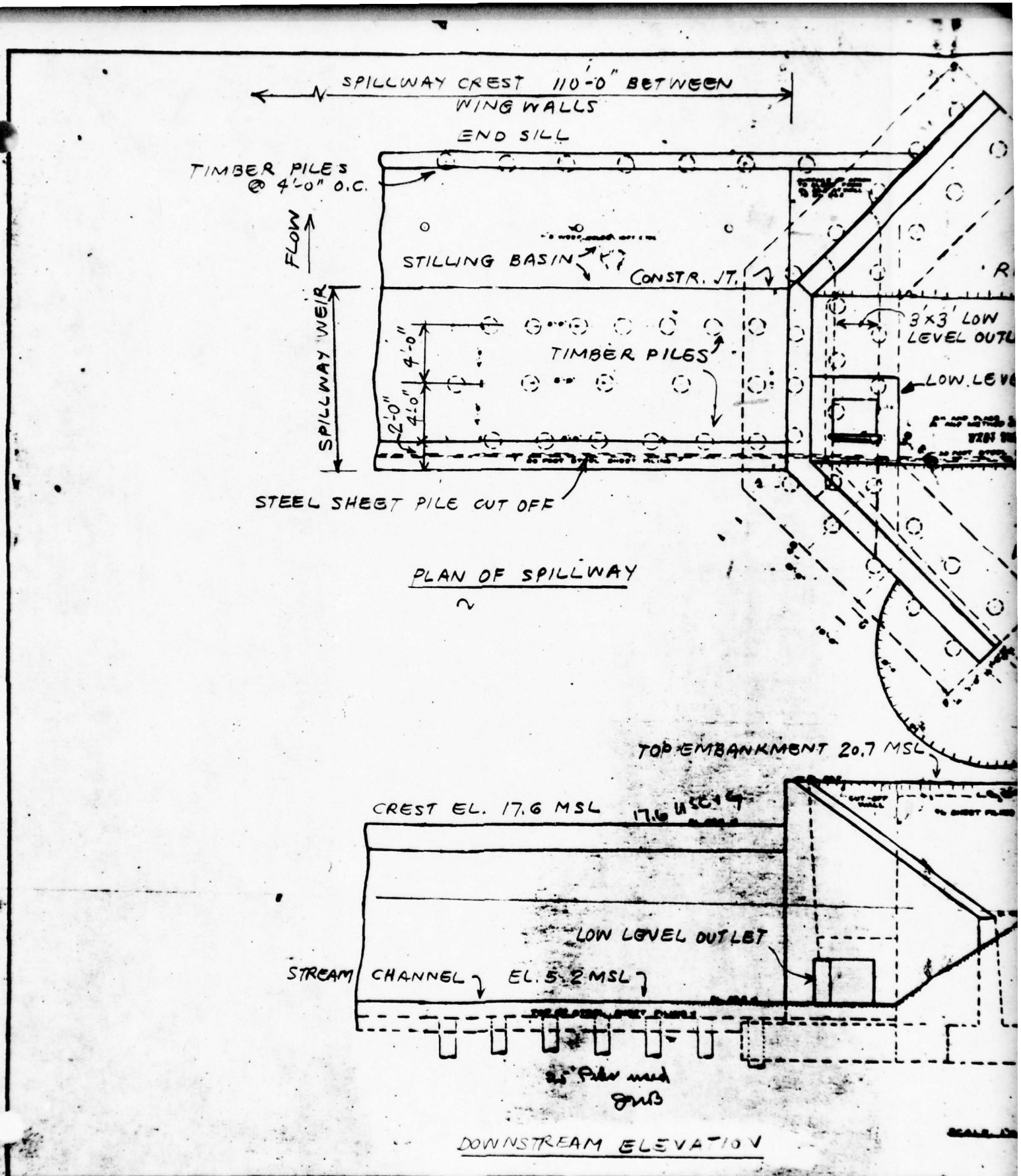
ORIGINAL DRAWING REDRAWN FOR CLARITY

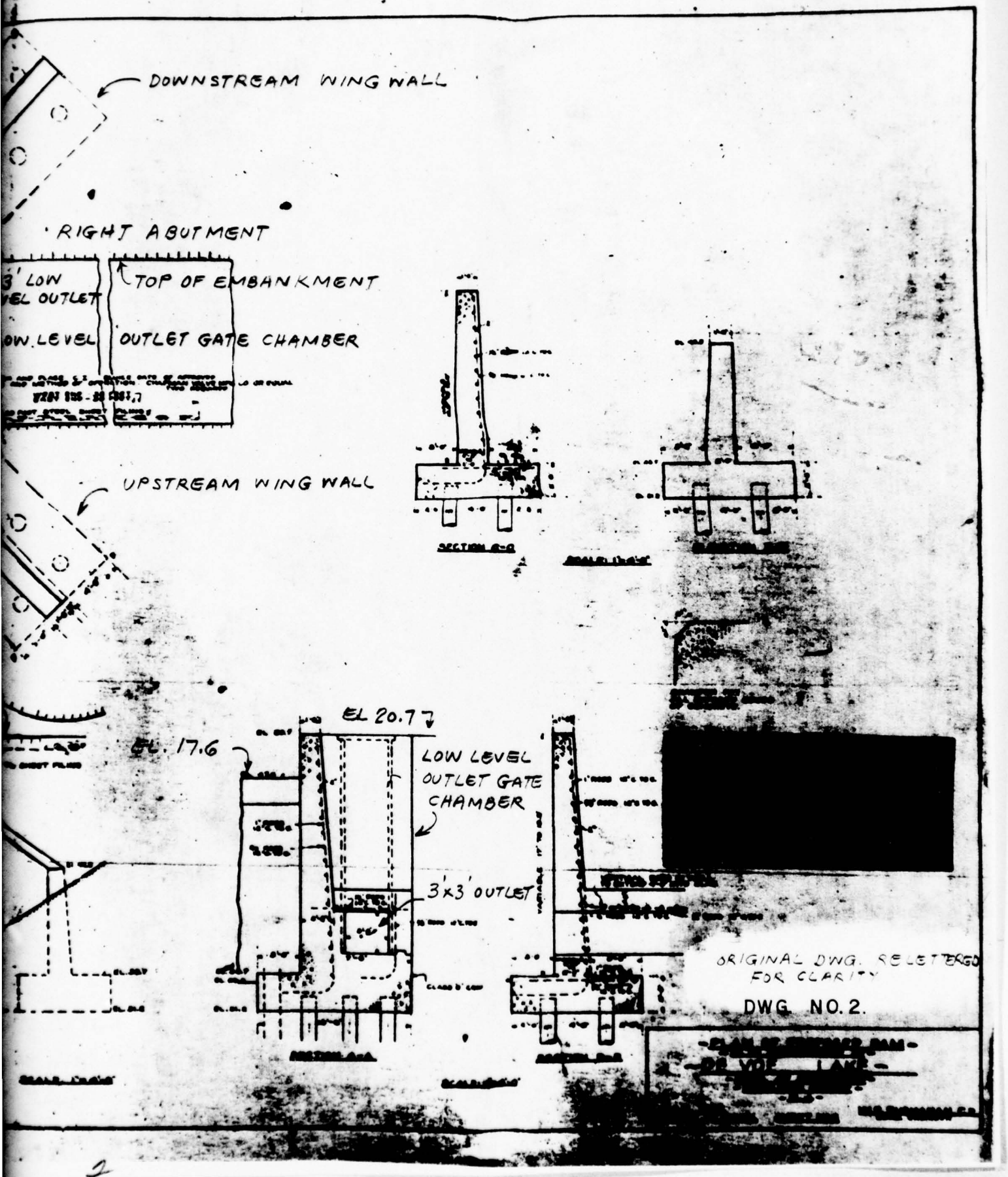
SCALE 1"=200'

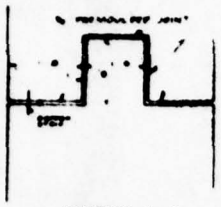
PLAN OF RESERVOIR

-PLAN OF PROPOSED DAM-
-DE VOE'S MILL POND-

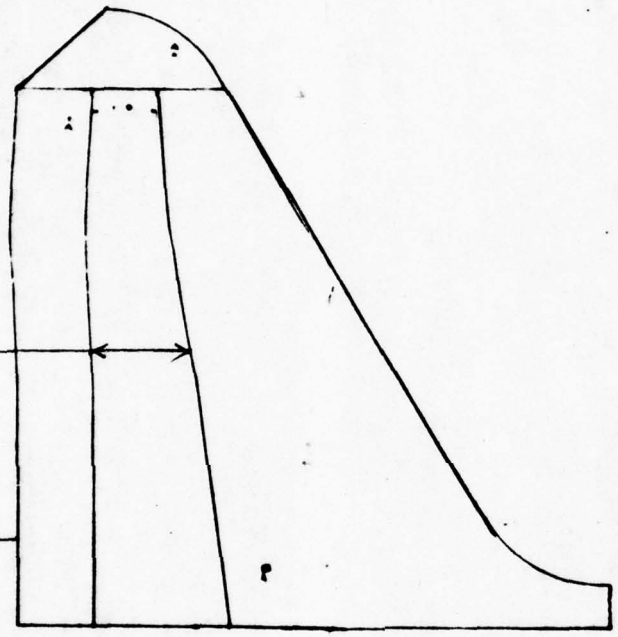
MAR. 1938

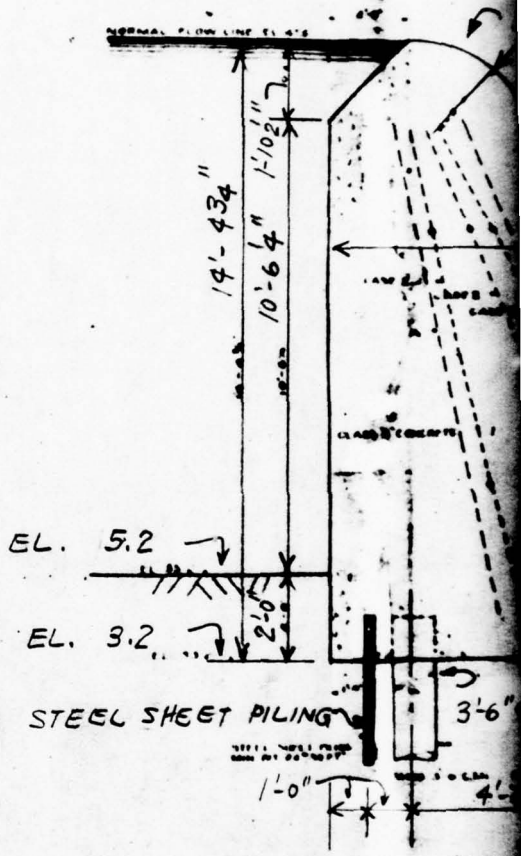

SPILLWAY CREST 110'-0" BETWEEN WING WALLS
END SILL
TIMBER PILES @ 4'-0" O.C.
FLOW
STILLING BASIN
CONSTR. JT.
SPILLWAY WEIR
4'-0"
4'-0"
2'-0"
TIMBER PILES
3'x3' LOW LEVEL OUTL
LOW LEVE
STEEL SHEET PILE CUT OFF
PLAN OF SPILLWAY
TOP EMBANKMENT 20.7 MSL
CREST EL. 17.6 MSL
17.6 U.S.C.&G.
LOW LEVEL OUTLET
STREAM CHANNEL
EL. 5.2 MSL
DOWNSTREAM ELEVATION

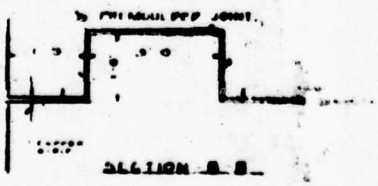

DOWNSTREAM WING WALL
RIGHT ABUTMENT
TOP OF EMBANKMENT
OUTLET GATE CHAMBER
UPSTREAM WING WALL
EL 20.77
EL. 17.6
LOW LEVEL
OUTLET GATE
CHAMBER
3'x3' OUTLET
ORIGINAL DWG. RELETTERED
FOR CLARITY
DWG. NO. 2.



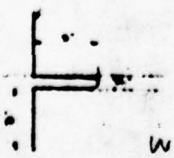
SECTION A-A





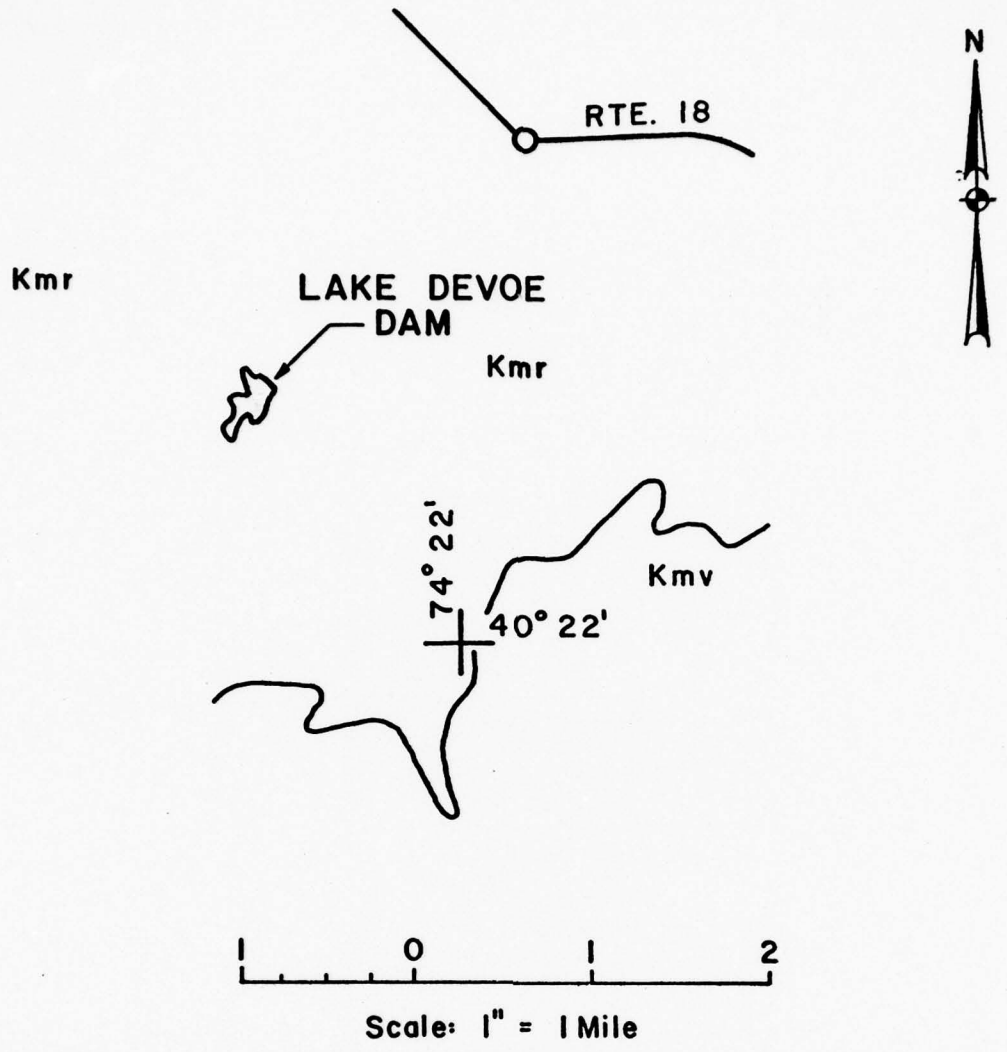


SECTION B-B



WATERSTOP DETAIL

MAXIMUM FLOW LINE 20.2 MSL
3'-0" RAD
SPILLWAY CREST 17.6 MSL
13'-6"
11'-0"
CONSTR. JT
END SILL
3' RAD
3"Φ WEEP HOLES @ 10 FT O.C.
CHANNEL BED EL. 5.2
3'-6" o/c
5'-0" o/c
3'-0" o/c
4'-0"
4'-0"
3'-0
3'-6"
CROSS SECTION OF DAM AND APRON
TIMBER PILES @ 4'-0 o/c
DWG. NO. 3.
ORIGINAL DWG. RELETTERED FOR CLARITY
-PLAN OF PROPOSED DAM-
-DE VOE LAKE -



LEGEND:

CRETACEOUS

Kmr Magothy and Raritan Formations
Dark Silty Clays and Light-Colored Sands(Km); Alternating Layers of Sand and Clays(Kr)

Kmv Merchantville Formation
Interstratified Glauconitic Sands and Thin Beds of Clayey Silt.

——— Contact

GEOLOGIC MAP
LAKE DEVOE

DWG. NO. 4

APPENDIX A

CHECK LIST - VISUAL OBSERVATIONS

CHECK LIST - ENGINEERING, CONSTRUCTION MAINTENANCE DATA

CHECK LIST
VISUAL INSPECTION
PHASE 1

Name Dam DEVOE LAKE DAM County Middlesex State New Jersey Coordinators

Date(s) Inspection May 4, 1978
May 5, 1978
May 8, 1978 Weather Sunny
Overcast
Overcast Temperature 55°F
55°F
60°F

Pool Elevation at Time of Inspection 17.8 M.S.L.** Tailwater at Time of Inspection 10.0 M.S.L.

Inspection Personnel:

Seymour Roth, May 4, 5 and 8
David Kerkes, May 4, 5 and 8
Yin Au-Yeung, May 5
William Flynn, May 8
Lynn Brown, May 8
Lawrence Woscyna, May 5
NJ-D.E.P.

Recorder: Seymour M. Roth

Representing the Borough of Spotswood: on May 5, 1978
Mr. Harold Snure, Superintendent
Department of Public Works
Borough of Spotswood

** The water surface on May 4 and 5, 1978, was approximately 2 inches above crest level; on May 8, the pool was drawn down to spillway crest level and the spillway face could be observed in the dry.

CONCRETE/MASONRY DAMS (1)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
SEEPAGE OR LEAKAGE	No seepage visible at concrete spillway section.	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Steel sheet piling visible on left abutment in the vicinity of the spillway wingwall (see "Any noticeable seepage" on "Embankment").	
DRAINS	No drains have been installed in dam. Drains in stilling basin apron were not visible for inspection.	
WATER PASSAGES	Water passages of low level outlet on either side of the spillway are not available for inspection because they are below head and tailwater level.	
FOUNDATIONS	Permeable sands and gravels on right abutment area. Fine to medium grained sand on left abutment area.	

(1) Pertains to concrete spillway overflow section of dam.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	The left spillway wingwall is severely spalled at the top surface and at its downstream end. The upstream end of left spillway wall is missing, the rest severely eroded and spalled. Reinforcement is exposed. The right abutment wingwall is spalled and eroded at zone of weir overflow. There is algeal growth on weir surfaces, but the concrete surface is in serviceable condition.	Repair and rebuild left abutment wall as required. Surface repair of eroded zone on right abutment wall recommended.
STRUCTURAL CRACKING	There is no structural cracking in evidence caused by overloads or settlements.	
VERTICAL & HORIZONTAL ALIGNMENT	The spillway alignment is good in both horizontal and vertical directions.	
MONOLITH JOINTS	There are four monolith joints on the spillway weir section, all in serviceable condition. No misalignments or offsets were observed.	
CONSTRUCTION JOINTS	No construction joint offsets could be observed. Water flow over the weir was smooth.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	There is some erosion of both downstream abutment slopes due to tailwater effects and local storm water run-off.	Regrade downstream abutment areas and protect with vegetative cover or stone surfacing.
VERTICAL & HORIZONTAL ALIGNMENT OF THE CREST	The abutments are wide and massive. No misalignments are detectable visually.	
RIPRAP FAILURES	There is no riprap protection on the downstream face of the abutments.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Severe erosion of embankment adjacent to left downstream spillway using wall. Embankment degradation adjacent to right downstream spillway wingwall. Loss of embankment adjacent to missing part of left upstream spillway wingwall.	Regrade embankment areas adjacent to downstream spillway wingwall and protect with riprap. Regrade embankment and protect with heavy stone armor.
ANY NOTICEABLE SEEPAGE	Seepage was observed in the right abutment, beginning approximately 8 ft. landward of the downstream spillway wingwall and extending approximately 12 ft. along the abutment crest, and is estimated at one gpm. Seepage detected on the embankment at the downstream end of the left spillway wingwall and extending 6-ft. downstream at or near tailwater level. Flow estimated at one gpm.	Channelize seepage and monitor estimated seepage flow at weekly intervals.
STAFF GAGE AND RECORDER	U.S.G.S. gaging station is in active use on right abutment; "Manalapan Brook of Spotswood", and measures the lake level.	
DRAINS	None observed.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CRACKING & SPALLING OF CONCRETE SURFACES IN STILLING BASIN	Water passages of 3 ft. x 3 ft. low level outlets built into each spillway wingwall, not observable due to headwater and tailwater inundation.	
INTAKE STRUCTURE	None	
OUTLET STRUCTURE	Sluice gate chambers concrete at top of abutment level is severely spalled and eroded. Cover slabs to gate chamber are ill fitting and not fully covering openings.	Repair concrete at embankment level and regrade. Provide new gate chamber cover slabs or plates.
OUTLET FACILITIES	None	
EMERGENCY GATE	None	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONCRETE WEIR	Concrete is in serviceable condition, the top of the ogee areas is smooth and well aligned.	
APPROACH CHANNEL	None	
DISCHARGE CHANNEL	Stilling basin downstream of spillway not visible under high tailwater.	Inspect stilling basin concrete and end sill for erosion and undercutting, either in dry or by diver.
BRIDGE AND PIERS	None	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONCRETE SILL	NA	
APPROACH CHANNEL	NA	
DISCHARGE CHANNEL	NA	
BRIDGE AND PIERS	NA	
GATES & OPERATION EQUIPMENT	NA	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
MONUMENTATION/ SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	U.S.G.S. gage "Manalapan Brook at Spotswood" on right reservoir rim at Devoe Lake Dam.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENTATIONS
SLOPES	Rim slopes are flat to very gently sloping. Reservoir has not been overtopped according to Borough Department of Public Works.	
SEDIMENTATION	A continuing problem: Reservoir has been partially dredged in 1972, to create extra depth on right lake shoreline adjacent to the spillway.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	No obstruction observed in downstream reach.	
SLOPES	Bank slopes are well defined, some erosion has taken place, and upgraded material has been dumped on the left channel bank for protection against further erosion.	Regrade left channel bank and protect with stone riprap.
APPROXIMATE NUMBER OF HOMES AND POPULATION	There is a large building on rightbank immediately downstream of the dam, other buildings exist further downstream.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Partial plan of spillway section available.
REGIONAL VICINITY MAP	Available
CONSTRUCTION HISTORY	Partly available in New Jersey Department of Environmental Protection files.
TYPICAL SECTIONS OF DAM	Only for concrete spillway, abutment embankment sections not available.
HYDROLOGIC/HYDRAULIC DATA	Gage data "Manalapan Brook at Spostswood available from U.S.G.S., Trenton.
OUTLETS - PLAN	)
- DETAILS	) Available; but in poor detail.
- CONSTRAINTS	)
- DISCHARGE RATINGS	Not available
RAINFALL / RESERVOIR RECORDS	No rainfall gages maintained in immediate dam area.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

ITEM	REMARKS
DESIGN REPORTS	None available
GEOLOGY REPORTS	None available
DESIGN COMPUTATIONS	None available
HYDROLOGY & HYDRAULICS	None available
DAM STABILITY	Indicated on design drawing but loadings not given
SEEPAGE STUDIES	None available
MATERIALS INVESTIGATIONS	None available
BORING RECORDS	Indicated on contract drawings
LABORATORY	None available
FIELD	None available
POST-CONSTRUCTION SURVEYS OF DAM	None available or made
BORROW SOURCES	Not known
SPILLWAY PLAN - SECTIONS	Available from contract drawings
- DETAILS	Available from contract drawings

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

ITEM	REMARKS
OPERATING EQUIPMENT PLANS AND DETAILS	None available
MONITORING SYSTEMS	None
MODIFICATIONS	None known to Department of Public Works Superintendent.
HIGH POOL RECORDS	U.S.G.S. gage "Manalapan Brook at Spotswood" has complete records.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None known
PRIOR ACCIDENTS OF FAILURE OF DAM - DESCRIPTION - REPORTS	None known
MAINTENANCE OPERATION RECORDS	Low level outlet operation records forwarded to U.S.G.S. for inclusion in discharge records.

APPENDIX B

PHOTOGRAPHS

ALL PHOTOGRAPHS WERE TAKEN IN MAY 1978

Photo 1 - View of Devoe Lake Dam seen from downstream

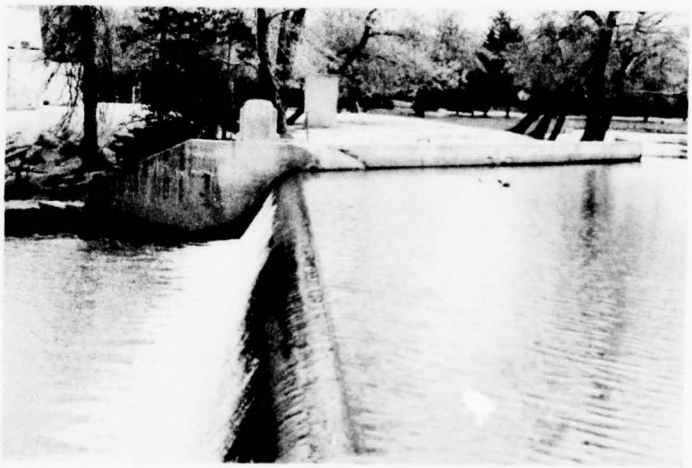


Photo 2 - View of the right abutment and upstream reservoir rim wall seen from the left abutment

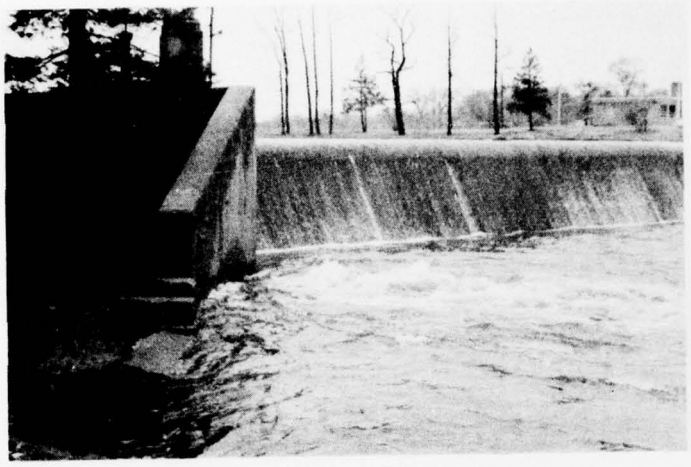


Photo 3 - View of the right abutment wingwall; the left low level outlet conduit is discharging, causing white surface water in the stilling basin area; Stilling basin apron is submerged under tailwater

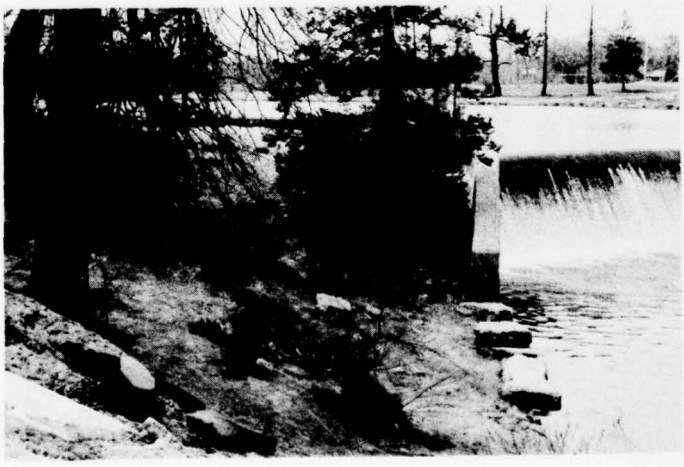


Photo 4 - View of the right abutment downstream face, including areas of seepage halfway between tree and end of the wingwall

Photo 5 - View of both abutments and spillway looking toward the right abutment, showing deteriorated surface concrete at the right low level outlet conduit, deteriorated left spillway training wall, and additional dumped downstream channel protection material

Photo 6 - View of the left abutment and spillway taken at a time when the pool was drawn down below the spillway crest for the inspection

Photo 7 - Close-up of the left abutment spillway wingwall showing deteriorated concrete

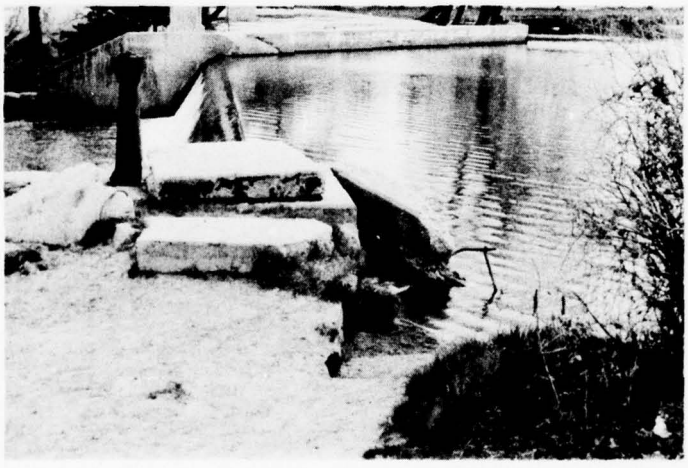


Photo 8 - View of the left abutment showing the deteriorated and missing upstream end of the spillway wingwall, and the gate operating stand for the left low level outlet conduit gate; the sheeet pile cut-off is exposed in the foreground

Photo 9 - Left low level outlet gate operating stand showing the missing gear cover

Photo 10 - Left abutment wingwall loking upstream, showing the eroded area in back of the spillway wingwall

Photo 11 - Downstream end of the left spillway wingwall showing concrete deterioration and source of abutment seepage adjacent to it

Photo 12 - General stream bank area downstream of the left spillway wingwall showing evidence of seepage

Photo 13 - View of the left downstream channel bank taken from the dam; additional dumped bank protection material has been placed

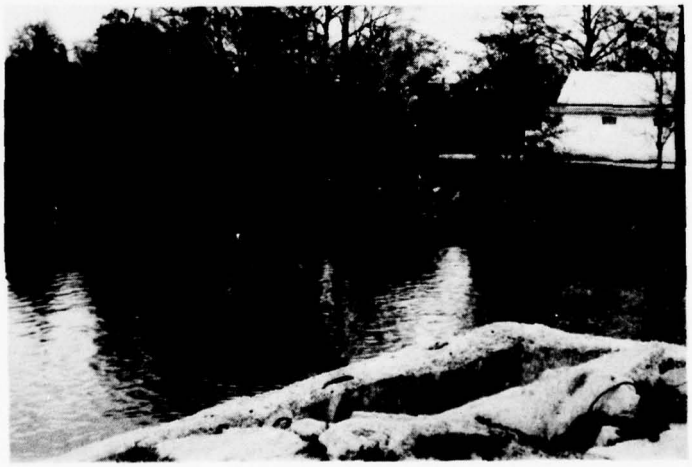


Photo 14 - View of the right downstream channel taken from the left dam abutment

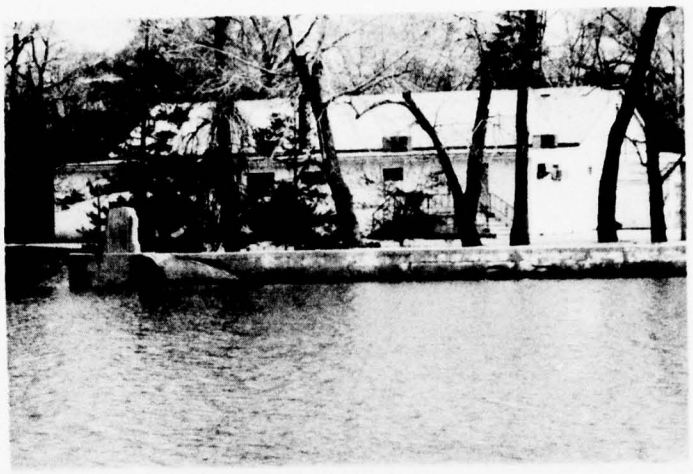


Photo 15 - View of the upstream reservoir rim wall on the right abutment

Photo 16 - View of the right reservoir rim taken from the dam axis

APPENDIX C

SUMMARY OF ENGINEERING DATA

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

Name of Dam: DEVOE LAKE DAM

Drainage Area Characteristics: 41 square miles on the Manalapan Brook of the Raritan River

Elevation Top Normal Pool (Storage Capacity): 17.6 MSL (230 AF)

Elevation Top Flood Control Pool (Storage Capacity): NA

Elevation Maximum Design Pool: 19.7

Elevation Top Dam: 20.7 (top of wingwall). Lowest point behind right wingwall is estimated at Elevation 19.7

SPILLWAY CREST:

a. Elevation 17.6 MSL
b. Type Concrete ogee overflow, ungated
c. Width Ogee crest
d. Length 110 feet
e. Location Spillover Mid-section of the structure
f. No. and Type of Gates None

OUTLET WORK:

a. Type 2 - 3 ft. x 3 ft. R.C. conduit with iron sluice gates at dam axis
b. Location One behind each spillway wingwall
c. Entrance Inverts Approximately 9.75 ft.
d. Exit Inverts Approximately 9.75 ft.
e. Emergency Draindown Facilities Through outlet works

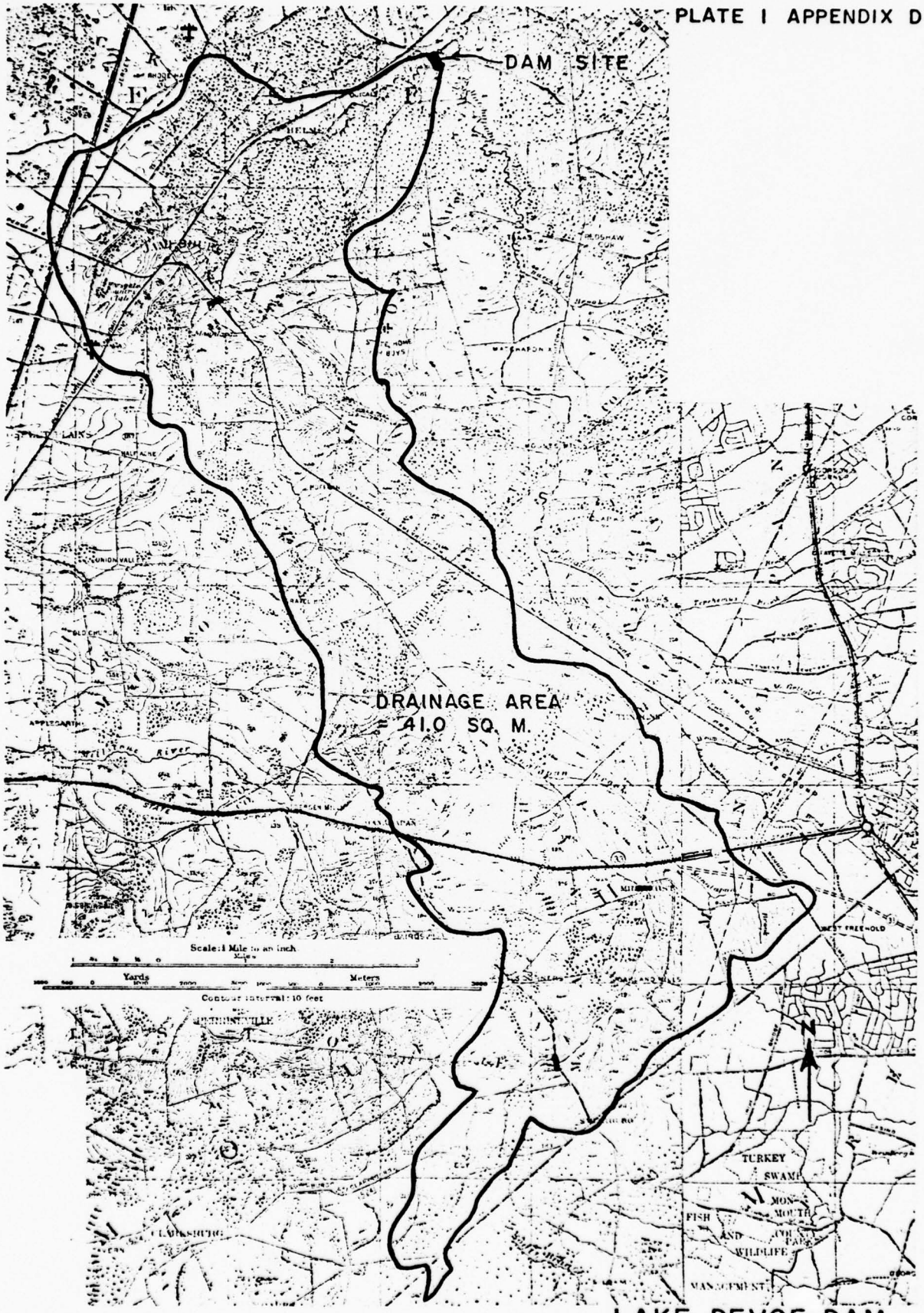
HYDROMETEOROLOGICAL GAGES:

a. Type U.S.G.S gaging station #0140540 staff gage
b. Location On the right wing wall of the spillway structure
c. Records January 1957 to current

MAXIMUM NON-DAMAGING DISCHARGE Approx. 2,000 cfs with both low level outlet gates open

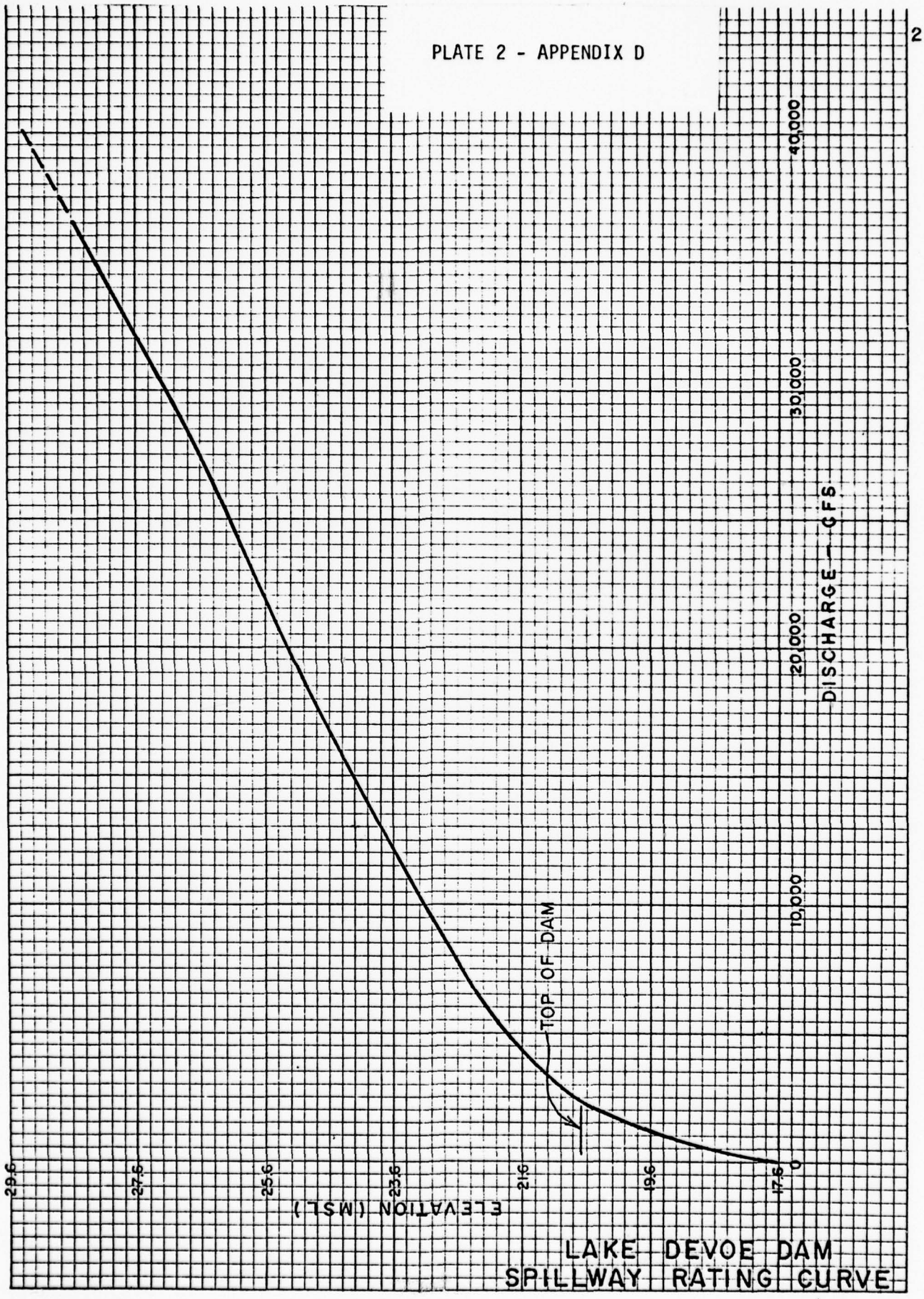
APPENDIX D

HYDROLOGIC COMPUTATIONS



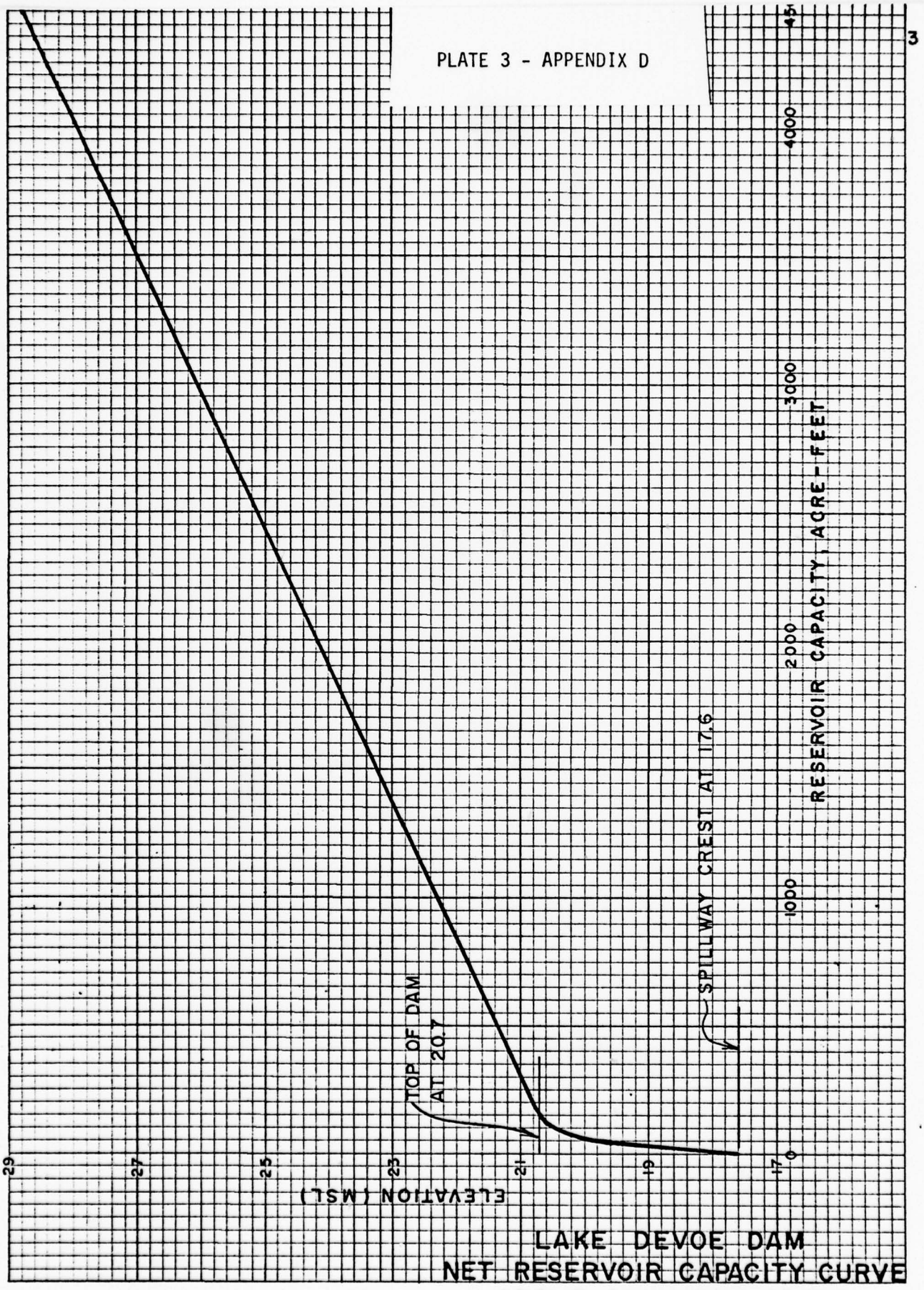
LAKE DEVOE DAM
DRAINAGE BASIN

PLATE 2 - APPENDIX D



LAKE DEVOE DAM
SPILLWAY RATING CURVE

PLATE 3 - APPENDIX D



LAKE DEVOE DAM
NET RESERVOIR CAPACITY CURVE
ABOVE SPILLWAY CREST

APPENDIX

HYDROLOGIC COMPUTATION

PROBABLE MAXIMUM FLOOD CALCULATION (PMF)

DRAINAGE AREA = 41.0 Square Miles.

From Hydrometeorological Report #33
"Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Duration of 6, 12, 24 and 48 Hours" 1956.

For Drainage Area 10 Square Miles
the 6 Hour duration PMP is 26 inches for Zone "6" at Lake Devoe watershed.

Since the drainage area is larger than 10 square miles, an area reduction factor of (.88 is applied.

The reduced 6 Hour PMP is .88 × 26 = 22.62 inches.

PMP values for rainfall durations of 6, 12, 24, 48 hours are:

Duration (Hrs)	PMP (inches)
6 Hr	1 × 22.62 = 22.62
12 Hr.	1.09 × 22.62 = 24.66
24 Hr.	1.17 × 22.62 = 26.47
48 Hr.	1.31 × 22.62 = 29.81

PMP values shown above are reduced by 16 % to account for misalignment of basin and rainfall isohyetals.

The PMP for deriving PMF are therefore as following:

Duration (Hrs)	PMP (inches)
6	19.00
12	20.71
24	22.23
48	25.04

PMP Rainfall Distribution (Corps Curve)

Distribution according to EM 1110-2-1411

Time (hr)	Total 6hr %	Total Rainfall (inch)	Incremental Rainfall Depth (inch)
1	10	1.90	1.90
2	22	4.18	2.28
3	37	7.03	2.85
4	75	14.25	7.22
5	89	16.91	2.66
6	100	19.00	2.09

DIRECT RUNOFF INCREMENT FOR COMPUTED PMF

Time ending (hr)	Incremental Design Rainfall (in)	Accumulative Design Rainfall (in)	Direct Runoff. Accumulative	Direct Runoff. Incremental	Incremental Loss
1	1.90	1.90	0.75	0.75	1.15
2	2.28	4.18	2.65	1.90	0.38
3	2.85	7.03	5.30	2.65	0.20
4	7.22	14.25	12.31	7.01	0.21
5	2.66	16.91	14.91	2.62	0.04 *
6	2.09	19.00	17.01	2.05	0.04 *

* Minimum loss rate 0.04"/hr.

DAM SAFETY INSPECTION — SHEET NO. 1 OF
PMF DETERMINATION — LOW DEVIL DAM — JOB NO. 1209-001-1
PROBABLE MAXIMUM PRECIPITATION — BY WLB — DATE 7-17-79

PMF RAINFALL DISTRIBUTION (MAY 12 HR)

DISTRIBUTION ACCORDING TO EC-1110-2-163

TIME (HR)	TOTAL 12 HR %	TOTAL RAINFALL (INCH)	INCREMENTAL RAINFALL (INCH)	DIRECT RUNOFF (PMF) ACCUM. (INCH)	DIRECT RUNOFF (PMF) INCREM. (INCH)	INCREMENTAL LOSS (INCH)
1	1.38	0.29	0.29	0	0	0.04
2	2.76	0.57	0.28	0.00	0.00	0.04
3	4.14	0.86	0.29	0.11	0.07	0.04
4	5.52	1.14	0.28	0.24	0.13	0.11
5	6.90	1.43	0.29	0.41	0.17	0.12
6	8.28	1.71	0.28	0.59	0.18	0.10
7	17.45	3.61	1.90	2.12	1.53	0.37
8	28.46	5.89	2.28	4.20	2.08	0.20
9	42.22	8.74	2.85	6.93	2.73	0.12
10	77.08	15.96	7.22	14.03	7.10	0.12
11	89.92	18.62	2.66	16.66	2.62	0.04
12	100.00	20.71	2.09	18.79	2.05	0.04

SOIL GROUP "D", USING CN 95

* MINIMUM LOSS RATE OF 0.04"/HR.

HEC 1 - COMPUTATIONS

LAKE 02410

****
HEC-1 VERSION DATED JAN 1973

****

DAM SAFETY INSPECTION - NEW JERSEY
LAKE DEVOE DAM
PERCENT OF PMF FLOOD ROUTING

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
65	1	0	0	0	0	0	0	4	0

JOPER	NWT
3	0

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INPUT CLARK COEFFICIENTS THEN MULTIPLY BY 0.5

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
2	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	0	41.00	0.00	41.00	0.00	0.075	0	0	0

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

UNIT HYDROGRAPH DATA
TC= 5.20 R= 9.71 NTA= 0

RECESSION DATA
STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP Q
SUM	18.65	18.65	491189.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE PMF HYDROGRAPH THRU LAKE DEVOE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
2	1	0	0	0	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	0

	NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
	0	0	0	0.000	0.000	0.000	-1.

STORAGE=	0.	25.	50.	75.	150.	400.	675.	1375.	2950.	5100.
OUTFLOW=	0.	600.	1300.	1800.	2300.	3400.	4700.	9500.	24200.	43000.

********** ********** ********** ********** **********

LAKE 92

RUNOFF SUMMARY, AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	2	2596.	2352.	1350.	566.	41.00
ROUTED TO	2	2367.	2257.	1348.	566.	41.00

DAM SAFETY INSPECTION - NEW JERSEY
LAKE DEVOE DAM
ONE-HALF PMF FLOOD ROUTING

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
65	1	0	0	0	0	0	0	0	0

JOPER	NWT
3	0

SUB-AREA RUNOFF COMPUTATION

INPUT CLARK COEFFICIENTS THEN MULTIPLY BY 0.5

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
2	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	0	41.00	0.00	41.00	0.00	0.500	0	0	0

PRECIP DATA

NP	STORM	DAJ	DAK
6	0.00	0.00	0.00

PRECIP PATTERN

0.75	1.90	2.65	7.04	2.62	2.05

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

UNIT HYDROGRAPH DATA

TC= 5.20 R= 9.71 NTA= 0

RECESSION DATA

STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

UNIT HYDROGRAPH 55 END-OF-PERIOD ORDINATES, LAG= 5.00 HOURS, CP= 0.38 VOL= 0.99

154.	576.	1156.	1698.	2022.	2027.	1842.	1661.	1499.	1352.
1219.	1100.	992.	895.	807.	728.	657.	592.	534.	482.
435.	392.	354.	319.	288.	259.	234.	211.	190.	172.
155.	140.	126.	113.	102.	92.	83.	75.	68.	61.
55.	49.	45.	40.	36.	33.	29.	26.	24.	21.
19.	17.	16.	14.	13.					

TIME	END-OF-PERIOD FLOW RAIN	EXCS	COMP Q
1	0.75	0.75	115.
2	1.90	1.90	725.
3	2.65	2.65	2371.
4	7.04	7.04	6085.
5	2.62	2.62	12258.
6	2.05	2.05	19829.
7	0.00	0.00	25759.
8	0.00	0.00	31174.
9	0.00	0.00	32214.
10	0.00	0.00	30693.
11	0.00	0.00	28139.
12	0.00	0.00	25411.
13	0.00	0.00	22922.
14	0.00	0.00	20677.
15	0.00	0.00	18652.
16	0.00	0.00	16825.
17	0.00	0.00	15177.
18	0.00	0.00	13691.
19	0.00	0.00	12350.
20	0.00	0.00	11140.
21	0.00	0.00	10049.
22	0.00	0.00	9065.
23	0.00	0.00	8177.
24	0.00	0.00	7376.
25	0.00	0.00	6653.
26	0.00	0.00	6002.
27	0.00	0.00	5414.
28	0.00	0.00	4883.
29	0.00	0.00	4405.
30	0.00	0.00	3974.
31	0.00	0.00	3584.
32	0.00	0.00	3233.
33	0.00	0.00	2917.
34	0.00	0.00	2631.
35	0.00	0.00	2373.
36	0.00	0.00	2141.
37	0.00	0.00	1931.
38	0.00	0.00	1742.
39	0.00	0.00	1571.
40	0.00	0.00	1417.
41	0.00	0.00	1278.
42	0.00	0.00	1153.
43	0.00	0.00	1040.
44	0.00	0.00	938.
45	0.00	0.00	846.
46	0.00	0.00	763.
47	0.00	0.00	688.
48	0.00	0.00	621.
49	0.00	0.00	560.
50	0.00	0.00	505.
51	0.00	0.00	456.
52	0.00	0.00	411.
53	0.00	0.00	371.
54	0.00	0.00	334.
55	0.00	0.00	302.
56	0.00	0.00	263.
57	0.00	0.00	215.
58	0.00	0.00	163.
59	0.00	0.00	63.
60	0.00	0.00	26.
61	0.00	0.00	0.
62	0.00	0.00	0.
63	0.00	0.00	0.
64	0.00	0.00	0.
65	0.00	0.00	0.
SUM	17.01	17.01	447782.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	32214.	29065.	16531.	6998.	447777.
INCHES		6.59	15.00	16.93	16.93
AC-FT		14419.	32806.	37025.	37025.

HYDROGRAPH ROUTING

ROUTE PMF HYDROGRAPH THRU LAKE DEVOE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
2	1	0	0	2	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
0	0	0	0.000	0.000	0.000	-1.

STORAGE=	0.	5.	30.	50.	650.	1650.	2650.	3650.	4650.	5650.
OUTFLOW=	0.	200.	800.	1700.	3000.	9500.	19000.	29500.	38400.	47500.

TIME	EOP STOR	AVG IN	EOP OUT
1	4.	115.	115.
2	16.	420.	435.
3	56.	1548.	1713.
4	246.	4228.	2126.
5	763.	9175.	3744.
6	1565.	16049.	8949.
7	2424.	23293.	16454.
8	3128.	29955.	24026.
9	3570.	31694.	28657.
10	3735.	31453.	30258.
11	3684.	29915.	29805.
12	3508.	26775.	28010.
13	3246.	24157.	25694.
14	3062.	21800.	23333.
15	2951.	19665.	21113.
16	2656.	17739.	19071.
17	2474.	16001.	17335.
18	2302.	14434.	15699.
19	2143.	13020.	14199.
20	1998.	11745.	12811.
21	1867.	10594.	11551.
22	1748.	9557.	10431.
23	1639.	8621.	9453.
24	1531.	7776.	8731.
25	1419.	7015.	8004.
26	1310.	6327.	7294.
27	1207.	5708.	6622.
28	1111.	5149.	5990.
29	1023.	4644.	5425.
30	942.	4189.	4902.
31	869.	3779.	4426.
32	803.	3409.	3995.
33	743.	3075.	3606.
34	689.	2774.	3253.
35	630.	2502.	2975.
36	584.	2257.	2757.
37	521.	2036.	2722.
38	454.	1836.	2576.
39	384.	1655.	2425.
40	314.	1494.	2272.
41	244.	1348.	2120.
42	175.	1216.	1971.
43	109.	1097.	1828.
44	48.	989.	1623.
45	26.	892.	695.
46	30.	805.	815.
47	27.	726.	717.
48	24.	655.	651.
49	22.	591.	587.
50	20.	533.	529.
51	18.	480.	477.
52	16.	433.	430.
53	15.	391.	388.
54	13.	353.	350.
55	12.	319.	316.
56	11.	292.	290.
57	9.	239.	236.
58	7.	139.	136.
59	4.	113.	113.
60	1.	45.	45.
61	0.	13.	13.
62	0.	0.	0.
63	0.	0.	0.
64	0.	0.	0.
65	0.	0.	0.
SUM			447835.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	30258.	27742.	16221.	6899.	447835.
INCHES		6.29	14.72	16.93	16.93
AC-FT		13763.	32191.	37030.	37030.

NEW JERSEY DAM SAFETY INSPECTIONS — SHEET NO. 1 OF 3
PMF DERIVATION - DEVOE LAKE DAM. — JOB NO. 1209-001
PROBABLE MAXIMUM FLOOD - UHG. — BY Y.N DATE MAY 1

DERIVATION OF UNIT HYDROGRAPH

This dam is located on the South Portion of the Raritan River Basin. The Clarks method and coefficients are adopted for the derivation of UHG using the following equati

$$t_c = 8.29(1.0+0.03I)^{-1.28}\left(\frac{D.A.}{S}\right)^{0.28}, \text{ and}$$

$$\frac{R}{t_c + R} = 0.65$$

where

D. A. = drainage area in square miles

S = watercourse slope, in feet per mile, defined as the average slope of the watercourse between points 10 and 85 percent of the distance upstream from the runoff site to the watershed boundary.

I = index of impervious cover in percent of total land area

t_c = time in hours from the end of a burst of rainfall excess to the inflection point on the recession limb of the resulting direct runoff hydrograph (Clark method)

R = discharge at the inflection point on the recession limb of the direct runoff hydrograph divided by the slope of the recession limb at that point, in hours (Clark method).

t_c = 5.20 hrs with I = 35%

R = 9.71 with I = 35%

NEW JERSEY DAM SAFETY INSPECTION — SHEET NO. 2 OF 3
PMF DERIVATION - DeVoe Lake Dam — JOB NO. 1209-001
PMF - UHG — BY MAS DATE 5/12

Soil Cover

Urban & Built up land Area

= 35%

Assume impervious cover in percent is equal to Urban & built up land areas in percent

Thus

$I = 35$

t_c

$$t_c = 8.29\left(1.0 + 0.03I\right)^{-1.28}\left(\frac{D.A.}{S}\right)^{0.28}$$

where

$I = 35$

$D.A = 40.1$ Sq. miles

$S = 7.86$ ft/mile

$$\therefore \quad t_c = 8.29\left(1 + .03 \times 35\right)^{-1.28}\left(\frac{40.1}{7.86}\right)^{0.28}$$

$$= \underline{5.22 \text{ hrs}}$$

$\therefore$ Use $t_c = 5.20$ hrs

ECI-4 ENGINEERING CONSULTANTS, INC.

NEW JERSEY DAM SAFETY INSPECTION — SHEET NO. 3 OF 3
PMF DERIVATION - DENOE DAM — JOB NO. 1209-001
PMF-UHG — BY MAS DATE 5/12/78

R

$$\frac{R}{t_c + R} = 0.65$$

$$R = 1.86\, t_c$$

$\therefore R = 9.71$, when $t_c = 5.20$ hrs.

LAKE DEVOE

****
HEC-1 VERSION DATED JAN 1973

****

DAM SAFETY INSPECTION - NEW JERSEY
LAKE DEVOE DAM
ONE HALF PMF FLOOD ROUTING

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
65	1	0	0	0	0	0	0	0	0

JOPER NWT
5 0

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INPUT CLARK COEFFICIENTS THEN MULTIPLY BY 0.5

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
2	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	0	41.00	0.00	41.00	0.00	0.500	0	0	0

PRECIP DATA

NP	STORM	DAJ	DAK
12	0.00	0.00	0.00

PRECIP PATTERN

0.00	0.00	0.07	0.13	0.17	0.18	1.53	2.00	2.73	7.10
2.62	2.05								

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

UNIT HYDROGRAPH DATA
TC= 5.20 R= 9.71 NTA= 0

RECESSION DATA
STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

UNIT HYDROGRAPH 55 END-OF-PERIOD ORDINATES, LAG= 5.00 HOURS, CP= 0.38 VOL= 0.99

154.	576.	1136.	1698.	2022.	2027.	1842.	1661.	1499.	1352.
1219.	1100.	992.	895.	807.	728.	657.	592.	534.	482.
435.	392.	354.	319.	288.	259.	234.	211.	190.	172.
155.	140.	126.	113.	102.	92.	83.	75.	68.	61.
55.	49.	45.	40.	36.	33.	29.	26.	24.	21.
19.	17.	16.	14.	13.					

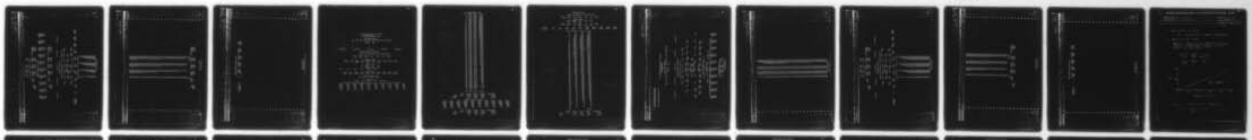
END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP Q
1	0.00	0.00	0.
2	0.00	0.00	0.

3	0.07	0.07	10.
4	0.13	0.13	60.
5	0.17	0.17	182.
6	0.18	0.18	394.
7	1.53	1.53	898.
8	2.08	2.08	2104.
9	2.73	2.73	4431.
10	7.10	7.10	8737.
11	2.62	2.62	15277.
12	2.05	2.05	22883.
13	0.00	0.00	29639.
14	0.00	0.00	33821.
15	0.00	0.00	34615.
16	0.00	0.00	32859.
17	0.00	0.00	30095.
18	0.00	0.00	27174.
19	0.00	0.00	24513.
20	0.00	0.00	22112.
21	0.00	0.00	19946.
22	0.00	0.00	17992.
23	0.00	0.00	16230.
24	0.00	0.00	14640.
25	0.00	0.00	13206.
26	0.00	0.00	11915.
27	0.00	0.00	10746.
28	0.00	0.00	9693.
29	0.00	0.00	8744.
30	0.00	0.00	7888.
31	0.00	0.00	7115.
32	0.00	0.00	6418.
33	0.00	0.00	5789.
34	0.00	0.00	5222.
35	0.00	0.00	4711.
36	0.00	0.00	4249.
37	0.00	0.00	3833.
38	0.00	0.00	3458.
39	0.00	0.00	3119.
40	0.00	0.00	2813.
41	0.00	0.00	2538.
42	0.00	0.00	2289.
43	0.00	0.00	2065.
44	0.00	0.00	1863.
45	0.00	0.00	1680.
46	0.00	0.00	1516.
47	0.00	0.00	1367.
48	0.00	0.00	1233.
49	0.00	0.00	1112.
50	0.00	0.00	1003.
51	0.00	0.00	905.
52	0.00	0.00	816.
53	0.00	0.00	736.
54	0.00	0.00	664.
55	0.00	0.00	599.
56	0.00	0.00	540.
57	0.00	0.00	487.
58	0.00	0.00	439.
59	0.00	0.00	396.
60	0.00	0.00	354.
61	0.00	0.00	317.
62	0.00	0.00	268.
63	0.00	0.00	217.

AD-A058 154 HARRIS ECI ASSOCIATES WOODBRIDGE NJ F/G 13/2
NATIONAL DAM SAFETY PROGRAM. DEVOE LAKE DAM (NJ00384). RARITAN --ETC(U)
JUN 78 R GERSHOWITZ DACW61-78-C-0100
UNCLASSIFIED NL

2 OF 2
AD A058154



END
DATE FILMED
10-78
DDC

64	0.00	0.00	163.
65	0.00	0.00	63.
SUM	18.65	18.65	491189.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	34615.	31367.	18002.	7556.	491186.
INCHES		7.11	16.33	18.57	18.57
AC-FT		15562.	35725.	40614.	40614.

RUNOFF MULTIPLIED BY 0.50

0.	0.	5.	30.	91.	197.	449.	1052.	2215.	4368.
7638.	11441.	14819.	16910.	17307.	16429.	15046.	13587.	12256.	11056.
9973.	8996.	8115.	7320.	6603.	5956.	5373.	4846.	4372.	3944.
3557.	3209.	2894.	2611.	2355.	2124.	1916.	1729.	1559.	1406.
1269.	1144.	1032.	931.	840.	758.	683.	616.	556.	501.
452.	408.	368.	332.	299.	270.	243.	219.	197.	177.
158.	134.	108.	81.	51.					

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	17307.	15683.	9001.	3778.	245593.
INCHES		3.55	8.16	9.28	9.28
AC-FT		7781.	17862.	20307.	20307.

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HYDROGRAPH ROUTING

ROUTE PMF HYDROGRAPH THRU LAKE DEVOL DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
2	1	0	0	0	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA
0	0	0	0.000	0.000	0.000	-1.

STORAGE=	0.	25.	50.	75.	150.	400.	675.	1375.	2950.	5100.
OUTFLOW=	0.	600.	1300.	1800.	2300.	3400.	4700.	9500.	24200.	43000.

TIME	EOP STOR	AVG IN	EOP OUT
1	0.	0.	0.
2	0.	0.	0.
3	0.	2.	2.
4	0.	17.	17.
5	2.	60.	60.
6	5.	144.	143.
7	13.	323.	322.
8	30.	750.	760.
9	66.	1633.	1635.
10	172.	3292.	2397.
11	424.	6003.	3513.
12	829.	9540.	5758.
13	1304.	13150.	9014.
14	1717.	15865.	12701.
15	1980.	17109.	15154.

LAKE DEVIL

16	2083.	16868.	16108.
17	2060.	15738.	15902.
18	1966.	14317.	15020.
19	1841.	12921.	13852.
20	1710.	11656.	12629.
21	1584.	10514.	11452.
22	1466.	9484.	10357.
23	1358.	8555.	9384.
24	1250.	7717.	8648.
25	1142.	6961.	7903.
26	1037.	6280.	7186.
27	939.	5664.	6514.
28	849.	5110.	5894.
29	766.	4609.	5327.
30	691.	4158.	4810.
31	619.	3750.	4435.
32	546.	3383.	4091.
33	474.	3052.	3751.
34	405.	2753.	3425.
35	339.	2483.	3134.
36	277.	2240.	2859.
37	218.	2020.	2601.
38	164.	1822.	2361.
39	116.	1644.	2076.
40	78.	1483.	1820.
41	55.	1338.	1406.
42	46.	1206.	1212.
43	42.	1088.	1079.
44	38.	982.	975.
45	34.	885.	879.
46	31.	799.	793.
47	29.	720.	715.
48	26.	650.	645.
49	24.	586.	583.
50	22.	529.	529.
51	19.	477.	477.
52	17.	430.	430.
53	16.	388.	388.
54	14.	350.	350.
55	13.	316.	316.
56	11.	285.	285.
57	10.	257.	257.
58	9.	231.	231.
59	8.	208.	208.
60	7.	187.	187.
61	6.	167.	167.
62	6.	146.	146.
63	5.	121.	121.
64	3.	95.	95.
65	2.	56.	57.
SUM			245576.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	16108.	14789.	8868.	3778.	245576.
INCHES		3.35	8.04	9.28	9.28
AC-FT		7337.	17599.	20306.	20306.

LAKE 020

RUNOFF SUMMARY, AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	2	17307.	15683.	9001.	3778.	41.00
ROUTED TO	2	16108.	14789.	8868.	3778.	41.00

DAM SAFETY INSPECTION - NEW JERSEY
LAKE DEVOE DAM
ONE HALF PMF FLOOD ROUTING

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
65	1	0	0	0	0	0	0	0	0

JOPER NWT
5 0

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INPUT CLARK COEFFICIENTS THEN MULTIPLY BY 0.5

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
2	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	0	41.00	0.00	41.00	0.00	0.500	0	0	0

PRECIP DATA

NP	STORM	DAJ	DAK
6	0.00	0.00	0.00

PRECIP PATTERN

0.75	1.90	2.65	7.04	2.62	2.05

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

UNIT HYDROGRAPH DATA

TC= 5.20 R= 9.71 NTA= 0

RECESSION DATA

STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

UNIT HYDROGRAPH 55 END-OF-PERIOD ORDINATES, LAG= 5.00 HOURS, CP= 0.38 VOL= 0.99

154.	576.	1156.	1698.	2022.	2027.	1842.	1661.	1499.	1352.
1219.	1100.	992.	895.	807.	728.	657.	592.	534.	482.
435.	392.	354.	319.	288.	259.	234.	211.	190.	172.
155.	140.	126.	113.	102.	92.	83.	75.	68.	61.
55.	49.	45.	40.	36.	33.	29.	26.	24.	21.
19.	17.	16.	14.	13.					

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP Q
1	0.75	0.75	115.
2	1.90	1.90	725.
3	2.65	2.65	2371.
4	7.04	7.04	6085.
5	2.62	2.62	12268.
6	2.05	2.05	19829.
7	0.00	0.00	25758.
8	0.00	0.00	31174.
9	0.00	0.00	32214.
10	0.00	0.00	30693.
11	0.00	0.00	28139.
12	0.00	0.00	25411.
13	0.00	0.00	22922.
14	0.00	0.00	20677.
15	0.00	0.00	18652.
16	0.00	0.00	16825.
17	0.00	0.00	15177.
18	0.00	0.00	13691.
19	0.00	0.00	12350.
20	0.00	0.00	11140.
21	0.00	0.00	10049.
22	0.00	0.00	9065.
23	0.00	0.00	8177.
24	0.00	0.00	7376.
25	0.00	0.00	6653.
26	0.00	0.00	6002.
27	0.00	0.00	5414.
28	0.00	0.00	4883.
29	0.00	0.00	4405.
30	0.00	0.00	3974.
31	0.00	0.00	3584.
32	0.00	0.00	3233.
33	0.00	0.00	2917.
34	0.00	0.00	2631.
35	0.00	0.00	2373.
36	0.00	0.00	2141.
37	0.00	0.00	1931.
38	0.00	0.00	1742.
39	0.00	0.00	1571.
40	0.00	0.00	1417.
41	0.00	0.00	1278.
42	0.00	0.00	1153.
43	0.00	0.00	1040.
44	0.00	0.00	938.
45	0.00	0.00	846.
46	0.00	0.00	763.
47	0.00	0.00	688.
48	0.00	0.00	621.
49	0.00	0.00	560.
50	0.00	0.00	505.
51	0.00	0.00	456.
52	0.00	0.00	411.
53	0.00	0.00	371.
54	0.00	0.00	334.
55	0.00	0.00	302.
56	0.00	0.00	263.
57	0.00	0.00	215.
58	0.00	0.00	163.
59	0.00	0.00	63.
60	0.00	0.00	26.
61	0.00	0.00	0.
62	0.00	0.00	0.
63	0.00	0.00	0.
64	0.00	0.00	0.
65	0.00	0.00	0.
SUM	17.01	17.01	447782.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	32214.	29065.	16531.	6888.	447777.
INCHES		6.59	15.00	16.93	16.93
AC-FT		14419.	32806.	37025.	37025.

RUNOFF MULTIPLIED BY 0.50

57.	362.	1185.	3042.	6134.	9914.	13379.	15587.	16107.	15346.
14069.	12705.	11461.	10338.	9326.	8412.	7588.	6845.	6175.	5570.
5024.	4532.	4088.	3688.	3326.	3001.	2707.	2441.	2202.	1987.
1792.	1616.	1455.	1315.	1186.	1070.	965.	871.	785.	708.
639.	576.	520.	469.	423.	381.	344.	310.	280.	252.
228.	205.	185.	167.	151.	131.	107.	81.	31.	13.
0.	0.	0.	0.	0.					

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	16107.	14532.	8265.	3444.	223888.
INCHES		3.29	7.50	8.46	8.46
AC-FT		7209.	16403.	18512.	18512.

HYDROGRAPH ROUTING

ROUTE PMF HYDROGRAPH THRU LAKE DEVOE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
2	1	0	0	2	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
0	0	0	0.000	0.000	0.000	-1.

STORAGE=	0.	9.	30.	50.	650.	1650.	2650.	3650.	4650.	5650.
OUTFLOW=	0.	200.	800.	1700.	3000.	9500.	19000.	29500.	38400.	47500.

TIME	EOP STOR	AVG IN	EOP OUT
1	2.	57.	57.
2	8.	210.	210.
3	30.	774.	814.
4	96.	2114.	1801.
5	308.	4588.	2259.
6	732.	8024.	3533.
7	1260.	11646.	6959.
8	1741.	14483.	10356.
9	2066.	15847.	13456.
10	2201.	15726.	14736.
11	2199.	14709.	14720.
12	2120.	13397.	13469.
13	2008.	12083.	12906.
14	1849.	10900.	11775.
15	1774.	9832.	10679.
16	1666.	8869.	9459.
17	1560.	8000.	8917.
18	1449.	7217.	8137.
19	1339.	6510.	7452.
20	1234.	5872.	6801.
21	1136.	5297.	6154.
22	1046.	4778.	5577.
23	964.	4311.	5041.
24	888.	3888.	4552.
25	820.	3507.	4110.
26	759.	3163.	3709.
27	703.	2854.	3347.
28	653.	2574.	3020.
29	608.	2322.	2933.
30	540.	2094.	2751.
31	473.	1889.	2618.
32	404.	1704.	2468.
33	334.	1537.	2315.
34	263.	1387.	2162.
35	194.	1251.	2013.
36	127.	1128.	1857.
37	62.	1018.	1728.
38	31.	918.	859.
39	30.	828.	816.
40	27.	747.	739.
41	25.	674.	659.
42	22.	608.	604.
43	20.	548.	544.
44	18.	494.	491.
45	17.	446.	443.
46	15.	402.	399.
47	14.	363.	350.
48	12.	327.	325.
49	11.	295.	293.
50	10.	266.	254.
51	9.	240.	238.
52	8.	215.	215.
53	8.	195.	194.
54	7.	176.	176.
55	6.	159.	159.
56	5.	141.	141.
57	4.	119.	119.
58	3.	94.	94.
59	2.	56.	56.
60	0.	22.	22.
61	0.	6.	6.
62	0.	0.	0.
63	0.	0.	0.
64	0.	0.	0.
65	0.	0.	0.
SUM			223917.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	14736.	13594.	8024.	3444.	223917.
INCHES		3.08	7.28	8.45	8.46
ACRFT		6744.	15924.	18515.	18515.

LAKE DEVOL

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HEC-1 VERSION DATED JAN 1973

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DAM SAFETY INSPECTION - NEW JERSEY
LAKE DEVOL DAM
PMF ROUTING

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
65	1	0	0	0	0	0	0	0	0

JOPER	NWT
5	0

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SUB-AREA RUNOFF COMPUTATION

INPUT CLARK COEFFICIENTS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
2	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	0	41.00	0.00	41.00	0.00	0.000	0	0	0

PRECIP DATA

NP	STORM	DAJ	DAK
12	0.00	0.00	0.00

PRECIP PATTERN

0.00	0.00	0.07	0.13	0.17	0.18	1.54	2.08	2.73	7.10
2.62	2.05								

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

UNIT HYDROGRAPH DATA
TC= 5.20 R= 9.71 NTA= 0

RECESSION DATA
STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

UNIT HYDROGRAPH 55 END-OF-PERIOD ORDINATES, LAG= 5.00 HOURS, CP= 0.38 VOL= 0.99

154.	376.	1156.	1698.	2022.	2027.	1842.	1661.	1499.	1352.
1219.	1100.	992.	895.	807.	728.	657.	592.	534.	482.
435.	392.	354.	319.	288.	259.	234.	211.	190.	172.
155.	140.	126.	113.	102.	92.	83.	75.	68.	61.
55.	49.	45.	40.	36.	33.	29.	26.	24.	21.
19.	17.	16.	14.	13.					

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP Q
1	0.00	0.00	0.
2	0.00	0.00	0.

3	0.07	0.07	10.
4	0.15	0.15	60.
5	0.17	0.17	182.
6	0.18	0.18	394.
7	1.55	1.55	898.
8	2.08	2.08	2104.
9	2.73	2.73	4451.
10	7.10	7.10	8737.
11	2.62	2.62	15277.
12	2.05	2.05	22885.
13	0.00	0.00	29659.
14	0.00	0.00	33821.
15	0.00	0.00	34615.
16	0.00	0.00	32859.
17	0.00	0.00	30095.
18	0.00	0.00	27174.
19	0.00	0.00	24513.
20	0.00	0.00	22112.
21	0.00	0.00	19946.
22	0.00	0.00	17992.
23	0.00	0.00	16230.
24	0.00	0.00	14640.
25	0.00	0.00	13206.
26	0.00	0.00	11913.
27	0.00	0.00	10746.
28	0.00	0.00	9693.
29	0.00	0.00	8744.
30	0.00	0.00	7888.
31	0.00	0.00	7115.
32	0.00	0.00	6418.
33	0.00	0.00	5789.
34	0.00	0.00	5222.
35	0.00	0.00	4711.
36	0.00	0.00	4249.
37	0.00	0.00	3833.
38	0.00	0.00	3458.
39	0.00	0.00	3119.
40	0.00	0.00	2813.
41	0.00	0.00	2538.
42	0.00	0.00	2289.
43	0.00	0.00	2065.
44	0.00	0.00	1863.
45	0.00	0.00	1680.
46	0.00	0.00	1516.
47	0.00	0.00	1367.
48	0.00	0.00	1233.
49	0.00	0.00	1112.
50	0.00	0.00	1003.
51	0.00	0.00	905.
52	0.00	0.00	816.
53	0.00	0.00	736.
54	0.00	0.00	664.
55	0.00	0.00	599.
56	0.00	0.00	540.
57	0.00	0.00	487.
58	0.00	0.00	439.
59	0.00	0.00	394.
60	0.00	0.00	354.
61	0.00	0.00	317.
62	0.00	0.00	268.
63	0.00	0.00	217.

LAKE DEVO

64	0.00	0.00	163.
65	0.00	0.00	65.
SUM	18.65	18.65	491189.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	34615.	31367.	18002.	7556.	491186.
INCHES		7.11	16.33	18.57	18.57
AC-FT		15562.	35725.	40614.	40614.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE PMF HYDROGRAPH THRU LAKE DEVOE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
2	1	0	0	2	0	1

ROUTING DATA

GLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
0	0	0	0.000	0.000	0.000	-1.

STORAGE=	0.	25.	50.	75.	150.	400.	675.	1375.	2950.	5100.
OUTFLOW=	0.	600.	1300.	1800.	2300.	3400.	4700.	9500.	24200.	43000.

TIME	EOP STOR	AVG IN	EOP OUT
1	0.	0.	0.
2	0.	0.	0.
3	0.	5.	5.
4	1.	35.	35.
5	5.	121.	120.
6	11.	288.	287.
7	26.	646.	648.
8	61.	1501.	1522.
9	169.	3267.	2366.
10	462.	6584.	3695.
11	1012.	12007.	7013.
12	1758.	19083.	13082.
13	2544.	26261.	20410.
14	3224.	31730.	26598.
15	3686.	34218.	30643.
16	3874.	33737.	32285.
17	3825.	31476.	31856.
18	3629.	28634.	30145.
19	3368.	25843.	27862.
20	3092.	23512.	25446.
21	2826.	21029.	23048.
22	2583.	18969.	20777.
23	2364.	17111.	18737.
24	2167.	15485.	16899.
25	1990.	13923.	15242.
26	1830.	12560.	13749.
27	1685.	11329.	12402.
28	1555.	10220.	11187.
29	1438.	9219.	10091.

LAKE B

30	1329.	8516.	9185.
31	1220.	7501.	8441.
32	1112.	6766.	7702.
33	1009.	6104.	6996.
34	913.	5506.	6338.
35	825.	4967.	5732.
36	744.	4480.	5179.
37	671.	4041.	4683.
38	599.	3645.	4344.
39	526.	3288.	3999.
40	455.	2966.	3661.
41	387.	2676.	3343.
42	322.	2413.	3057.
43	260.	2177.	2786.
44	203.	1964.	2553.
45	149.	1771.	2298.
46	104.	1598.	1996.
47	70.	1441.	1709.
48	51.	1300.	1339.
49	45.	1173.	1168.
50	41.	1058.	1050.
51	37.	954.	947.
52	34.	861.	854.
53	31.	776.	771.
54	28.	700.	695.
55	25.	632.	627.
56	23.	570.	568.
57	21.	514.	514.
58	19.	463.	463.
59	17.	416.	417.
60	15.	374.	374.
61	13.	335.	335.
62	12.	292.	292.
63	10.	242.	242.
64	7.	190.	190.
65	4.	113.	114.
SUM			491153.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	32285.	29898.	17756.	7556.	491153.
INCHES		6.78	16.11	18.57	18.57
AC-FT		14833.	35237.	40612.	40612.

LAKE 1 50

RUNOFF SUMMARY, AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	2	34615.	31367.	18002.	7556.	41.00
ROUTED TO	2	32285.	29898.	17756.	7556.	41.00

ECI-4 ENGINEERING CONSULTANTS, INC.

LAKE DE VOL DAM
RESERVOIR EVACUATION

SHEET NO. 1 OF
JOB NO. 1209-001-1
BY KLB DATE 7-19-77

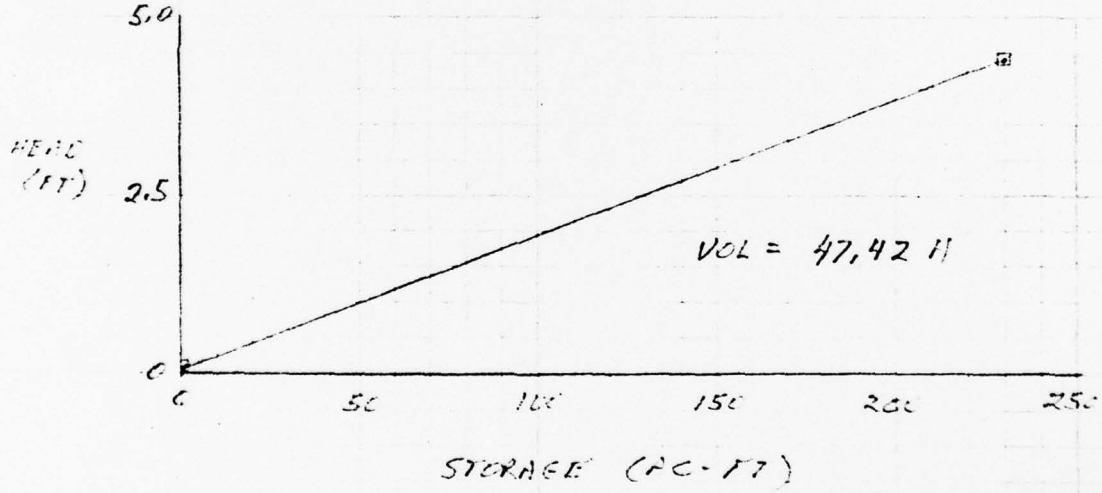
a) DISCHARGE VS. HEAD

$Q = 107.36\sqrt{H}$ (FROM WAS' NOTES)

b) STORAGE VS. HEAD

ASSUME A STRAIGHT LINE RELATIONSHIP FROM NORMAL WATER SURFACE VOLUME TO ZERO VOLUME AT ZERO HEAD

ELEV (FT)	HEAD (FT)	STORAGE (AC-FT)
17.60	4.85	230
12.75	0	0



c) JAMES, DRAINAGE AREA = 41 SQ. MI.

INFLOW = 2 CFS X 41 SQ. MI. = 82 CFS
SQ. MI.

ECI-4 ENGINEERING CONSULTANTS, INC.

LAKE [illegible] DAM
RESERVOIR EVACUATION

SHEET NO. ____ OF ____
JOB NO. ____
BY ____ DATE ____

d) RESERVOIR EVACUATION TIME WITH CONSTANT INFLOW

INFLOW = [illegible] CFS = 44 HR

(FROM COMPUTER PRINTOUT) = 1.83 DAYS

e) RESERVOIR EVACUATION TIME WITH ZERO INFLOW

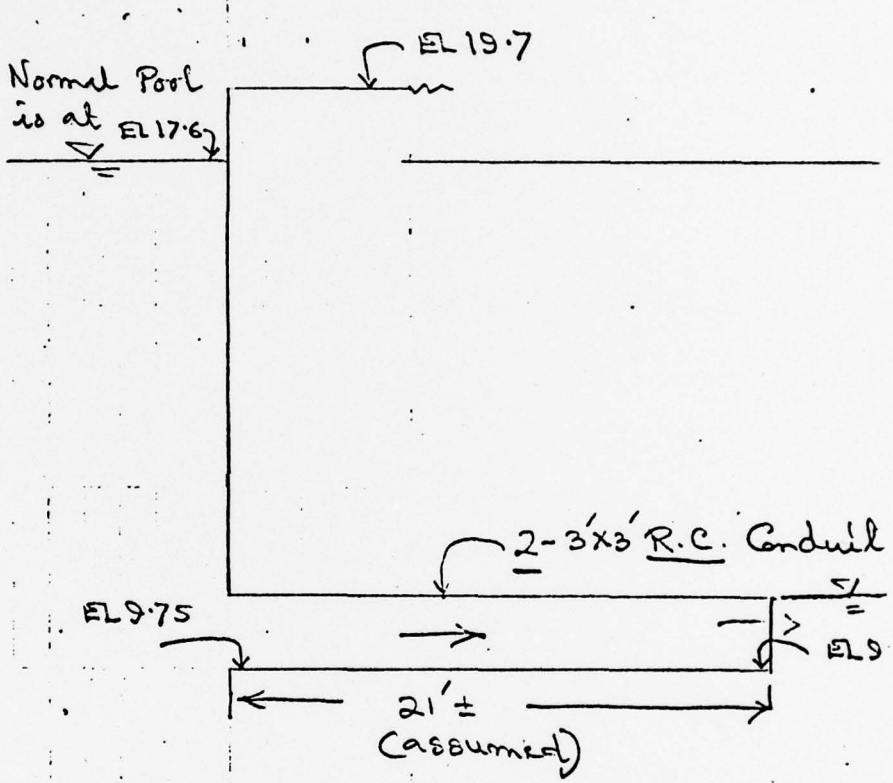
EVACUATION TIME = 20 HR

(FROM COMPUTER) = 0.83 DAY

LAKE DEVOE DAM

Outlet Works

1. Dimensions (from Hydrologic and Hydraul Data Sheet) and assumed position.



2. Determination of Outlet Capacity

Assumptions:

1. Outlet is submerged and the downstr water surface is just at the top of the pipe
2. Square edge at entrance ⇒ $K_e = 0.7$

NEW JERSEY DAM SAFETY INSPECTION — SHEET NO. 2 OF 3
LAKE DEVOE DAM — JOB NO. 1209-001
OUTLET CAPACITY — BY JJAS DATE 6-12

Solution:

$$HR = \frac{A}{P} = \frac{3\times3}{4\times3} = 0.75$$

Assuming rough surface,

$$\epsilon = .010$$

$$\therefore \frac{\epsilon}{4HR} = \frac{.010}{4\times.75} = 0.0033$$

$$\Rightarrow f = 0.0155$$

$$\therefore H = He + Hexit + hy$$

$$= Ke\frac{V^2}{2g} + \frac{V^2}{2g} + f\frac{L}{4R}\frac{V^2}{2g}$$

$$= \left[0.7+1+\frac{.0155\times21}{4\times.75}\right]\frac{V^2}{2g} = 1.81\frac{V^2}{2g} = 1.81\frac{}{}$$

$$= 1.81\frac{Q^2}{64.4\times9^2}$$

$$Q = \sqrt{\frac{81\times64.4}{1.81}}\sqrt{H} = 53.68\sqrt{H}$$

At Normal Pool Level, $H = 17.6-9.75-3 = 4$

$$V = \frac{53.68\sqrt{4.85}}{9} = 13.14$$

$$R = \frac{V4HR}{\nu} = \frac{13.14\times.75\times4}{10^5} = 3.94\times10^6$$

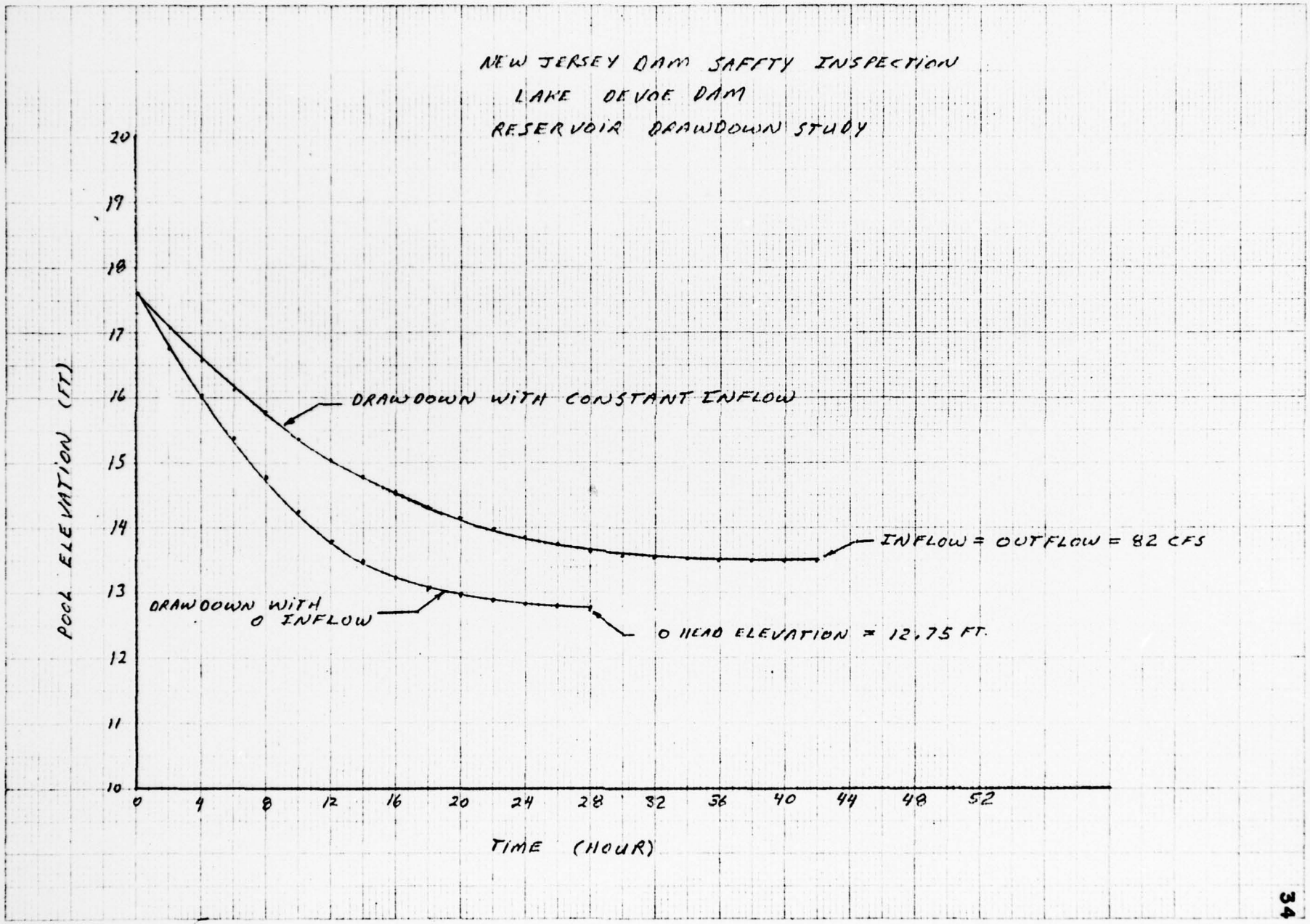
O.K. Complete tabulation

NEW JERSEY DATA SHEET: INJECTION SHEET NO. 3

LAKE DEVOE DAM JOB NO. 1209-

OUTLET CAPACITY BY JAS DAT

	Water Surface Elev. behind Dam	H feet	$Q = 53.68\sqrt{H}$ cfs	Total discharge = 2Q cfs.
Top of dam El. 20.7 ↓	17.6	4.85	118	236
	19.6	6.85	140	280
Assume dam will be raised ↓ ↓	21.6	8.85	160	320
	23.6	10.85	177	354
	25.6	12.85	192	384
	27.6	14.85	207	414
	29.6	16.85	220	440


NEW JERSEY DAM SAFETY INSPECTION
LAKE DEVOE DAM
RESERVOIR DRAWDOWN STUDY
POOL ELEVATION (FT.)
20
19
18
17
16
15
14
13
12
11
10
0
4
8
12
16
20
24
28
32
36
40
44
48
52
TIME (HOUR)
DRAWDOWN WITH CONSTANT INFLOW
INFLOW = OUTFLOW = 82 CFS
DRAWDOWN WITH
0 INFLOW
0 HEAD ELEVATION = 12.75 FT.

7-19-78

LAKE DEVOE DAM RESERVOIR DRAWDOWN STUDY (SA = 41 SQ. MI.)

2.0000 UNREGULATED DIVERSION CONDUIT AT ELEV 12.75 FT

MAXIMUM OPERATION LEVEL AT ELEV 17.60 FT (FROM OPERATI
MINIMUM OPERATION LEVEL AT ELEV 12.75 FT

ROUTING STARTS AT ELEV 17.60 FT, ENDS AT ELEV 12.75 FT

TIME		AVG. INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
0	0		17.60			
		0.				
0	2		16.78	0.	0.	215.
		0.				
0	4		16.03	0.	0.	195.
		0.				
0	6		15.36	0.	0.	174.
		0.				
0	8		14.76	0.	0.	153.
		0.				
0	10		14.24	0.	0.	135.
		0.				
0	12		13.79	0.	0.	112.
		0.				
0	14		13.45	0.	0.	77.
		0.				
0	16		13.22	0.	0.	49.
		0.				
0	18		13.06	0.	0.	34.
		0.				
0	20		12.96	0.	0.	24.
		0.				
0	22		12.88	0.	0.	18.
		0.				
1	0		12.82	0.	0.	14.
		0.				
1	2		12.78	0.	0.	11.
		0.				
1	4		12.75	0.	0.	9.

****

RESERVOIR ELEVATION WENT UNDER MINIMUM WATERSURFACE ELEVATION
AFTER 1 DAYS AND 4 HOURS

TOTAL INFLOW VOLUME	0.	ACFT
TOTAL DISCHARGE VOLUME	230.	ACFT
MAXIMUM WATER SURFACE ELEVATION	17.60	FT
MAXIMUM DISCHARGE THRU DIVERSION CONDUIT	215.	CFS
MAXIMUM TOTAL INFLOW	0.	CFS
MAXIMUM TOTAL DISCHARGE	236.	CFS

LAKE DEVOE DAM RESERVOIR DRAWDOWN STUDY (SA = 41 SQ. MI.)

2.0000 UNREGULATED DIVERSION CONDUIT AT ELEV 12.75 FT

MAXIMUM OPERATION LEVEL AT ELEV 17.60 FT (FROM OPERATI
MINIMUM OPERATION LEVEL AT ELEV 12.75 FT

ROUTING STARTS AT ELEV 17.60 FT, ENDS AT ELEV 12.75 FT

TIME		AVG. INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
0	0		17.60			
		82.				
0	2		17.06	0.	0.	223.
		82.				
0	4		16.57	0.	0.	210.
		82.				
0	6		16.13	0.	0.	197.
		82.				
0	8		15.73	0.	0.	185.
		82.				
0	10		15.37	0.	0.	174.
		82.				
0	12		15.06	0.	0.	164.
		82.				
0	14		14.78	0.	0.	153.
		82.				
0	16		14.54	0.	0.	145.
		82.				
0	18		14.32	0.	0.	138.
		82.				
0	20		14.13	0.	0.	130.
		82.				
0	22		13.97	0.	0.	122.
		82.				
1	0		13.83	0.	0.	115.
		82.				
1	2		13.73	0.	0.	108.
		82.				
1	4		13.64	0.	0.	102.
		82.				
1	6		13.58	0.	0.	97.
		82.				
1	8		13.54	0.	0.	90.
		82.				
1	10		13.51	0.	0.	87.

TIME		AVG. INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
		82.				
1	12		13.50	0.	0.	85.
		82.				
1	14		13.49	0.	0.	84.
		82.				
1	16		13.49	0.	0.	83.
		82.				
1	18		13.48	0.	0.	83.
		82.				
1	20		13.48	0.	0.	82.
		82.				
1	22		13.48	0.	0.	82.
		82.				
2	0		13.48	0.	0.	82.
		82.				
2	2		13.48	0.	0.	82.
		82.				
2	4		13.48	0.	0.	82.
		82.				
2	6		13.48	0.	0.	82.
		82.				
2	8		13.48	0.	0.	82.
		82.				
2	10		13.48	0.	0.	82.
		82.				
2	12		13.48	0.	0.	82.
		82.				
2	14		13.48	0.	0.	82.
		82.				
2	16		13.48	0.	0.	82.
		82.				
2	18		13.48	0.	0.	82.
		82.				
2	20		13.48	0.	0.	82.
		82.				
2	22		13.48	0.	0.	82.
		82.				
3	0		13.48	0.	0.	82.
		82.				
3	2		13.48	0.	0.	82.
		82.				
3	4		13.48	0.	0.	82.
		82.				
3	6		13.48	0.	0.	82.
		82.				
3	8		13.48	0.	0.	82.

TIME		AVG.INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
3	10	82.	13.48	0.	0.	82.
3	12	82.	13.48	0.	0.	82.
3	14	82.	13.48	0.	0.	82.
3	16	82.	13.48	0.	0.	82.
3	18	82.	13.48	0.	0.	82.
3	20	82.	13.48	0.	0.	82.
3	22	82.	13.48	0.	0.	82.
4	0	82.	13.48	0.	0.	82.
4	2	82.	13.48	0.	0.	82.
4	4	82.	13.48	0.	0.	82.
4	6	82.	13.48	0.	0.	82.
4	8	82.	13.48	0.	0.	82.
4	10	82.	13.48	0.	0.	82.
4	12	82.	13.48	0.	0.	82.
4	14	82.	13.48	0.	0.	82.
4	16	82.	13.48	0.	0.	82.
4	18	82.	13.48	0.	0.	82.
4	20	82.	13.48	0.	0.	82.
4	22	82.	13.48	0.	0.	82.
5	0	82.	13.48	0.	0.	82.
5	2	82.	13.48	0.	0.	82.
5	4	82.	13.48	0.	0.	82.
5	6	82.	13.48	0.	0.	82.

TIME		AVG. INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
5	8	82.	13.48	0.	0.	82.
5	10	82.	13.48	0.	0.	82.
5	12	82.	13.48	0.	0.	82.
5	14	82.	13.48	0.	0.	82.
5	16	82.	13.48	0.	0.	82.
5	18	82.	13.48	0.	0.	82.
5	20	82.	13.48	0.	0.	82.
5	22	82.	13.48	0.	0.	82.
6	0	82.	13.48	0.	0.	82.
6	2	82.	13.48	0.	0.	82.
6	4	82.	13.48	0.	0.	82.
6	6	82.	13.48	0.	0.	82.
6	8	82.	13.48	0.	0.	82.
6	10	82.	13.48	0.	0.	82.
6	12	82.	13.48	0.	0.	82.
6	14	82.	13.48	0.	0.	82.
6	16	82.	13.48	0.	0.	82.
6	18	82.	13.48	0.	0.	82.
6	20	82.	13.48	0.	0.	82.
6	22	82.	13.48	0.	0.	82.
7	0	82.	13.48	0.	0.	82.
7	2	82.	13.48	0.	0.	82.
7	4	82.	13.48	0.	0.	82.

TIME		AVG. INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
7	6	82.	13.48	0.	0.	82.
7	8	82.	13.48	0.	0.	82.
7	10	82.	13.48	0.	0.	82.
7	12	82.	13.48	0.	0.	82.
7	14	82.	13.48	0.	0.	82.
7	16	82.	13.48	0.	0.	82.
7	18	82.	13.48	0.	0.	82.
7	20	82.	13.48	0.	0.	82.
7	22	82.	13.48	0.	0.	82.
8	0	82.	13.48	0.	0.	82.
8	2	82.	13.48	0.	0.	82.
8	4	82.	13.48	0.	0.	82.
8	6	82.	13.48	0.	0.	82.
8	8	82.	13.48	0.	0.	82.
8	10	82.	13.48	0.	0.	82.
8	12	82.	13.48	0.	0.	82.
8	14	82.	13.48	0.	0.	82.
8	16	82.	13.48	0.	0.	82.
8	18	82.	13.48	0.	0.	82.
8	20	82.	13.48	0.	0.	82.
8	22	82.	13.48	0.	0.	82.
9	0	82.	13.48	0.	0.	82.
9	2	82.	13.48	0.	0.	82.

TIME		AVG. INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
		82.				
9	4		13.46	0.	0.	82.
		82.				
9	6		13.48	0.	0.	82.
		82.				
9	8		13.48	0.	0.	82.
		82.				
9	10		13.48	0.	0.	82.
		82.				
9	12		13.48	0.	0.	82.
		82.				
9	14		13.48	0.	0.	82.
		82.				
9	16		13.48	0.	0.	82.
		82.				
9	18		13.48	0.	0.	82.
		82.				
9	20		13.48	0.	0.	82.
		82.				
9	22		13.48	0.	0.	82.
		82.				
10	0		13.48	0.	0.	82.
		82.				
10	2		13.48	0.	0.	82.
		82.				
10	4		13.48	0.	0.	82.
		82.				
10	6		13.48	0.	0.	82.
		82.				
10	8		13.48	0.	0.	82.
		82.				
10	10		13.48	0.	0.	82.
		82.				
10	12		13.48	0.	0.	82.
		82.				
10	14		13.48	0.	0.	82.
		82.				
10	16		13.48	0.	0.	82.
		82.				
10	18		13.48	0.	0.	82.
		82.				
10	20		13.48	0.	0.	82.
		82.				
10	22		13.48	0.	0.	82.
		82.				
11	0		13.48	0.	0.	82.

TIME		AVG. INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
11	2	82.	13.48	0.	0.	82.
11	4	82.	13.48	0.	0.	82.
11	6	82.	13.48	0.	0.	82.
11	8	82.	13.48	0.	0.	82.
11	10	82.	13.48	0.	0.	82.
11	12	82.	13.48	0.	0.	82.
11	14	82.	13.48	0.	0.	82.
11	16	82.	13.48	0.	0.	82.
11	18	82.	13.48	0.	0.	82.
11	20	82.	13.48	0.	0.	82.
11	22	82.	13.48	0.	0.	82.
12	0	82.	13.48	0.	0.	82.
12	2	82.	13.48	0.	0.	82.
12	4	82.	13.48	0.	0.	82.
12	6	82.	13.48	0.	0.	82.
12	8	82.	13.48	0.	0.	82.
12	10	82.	13.48	0.	0.	82.
12	12	82.	13.48	0.	0.	82.
12	14	82.	13.48	0.	0.	82.
12	16	82.	13.48	0.	0.	82.
12	18	82.	13.48	0.	0.	82.
12	20	82.	13.48	0.	0.	82.
12	22		13.48	0.	0.	82.

TIME		AVG. INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARG
DAY	HR	CFS	FT	CFS	CFS	CFS
13	0	82.	13.48	0.	0.	82.
13	2	82.	13.48	0.	0.	82.
13	4	82.	13.48	0.	0.	82.
13	6	82.	13.48	0.	0.	82.
13	8	82.	13.48	0.	0.	82.
13	10	82.	13.48	0.	0.	82.
13	12	82.	13.48	0.	0.	82.
13	14	82.	13.48	0.	0.	82.
13	16	82.	13.48	0.	0.	82.
13	18	82.	13.48	0.	0.	82.
13	20	82.	13.48	0.	0.	82.
13	22	82.	13.48	0.	0.	82.
14	0	82.	13.48	0.	0.	82.
14	2	82.	13.48	0.	0.	82.
14	4	82.	13.48	0.	0.	82.
14	6	82.	13.48	0.	0.	82.
14	8	82.	13.48	0.	0.	82.
14	10	82.	13.48	0.	0.	82.
14	12	82.	13.48	0.	0.	82.
14	14	82.	13.48	0.	0.	82.
14	16	82.	13.48	0.	0.	82.
14	18	82.	13.48	0.	0.	82.
14	20	82.	13.48	0.	0.	82.

TIME		AVG. INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
		82.				
14	22		13.48	0.	0.	82.
		82.				
15	0		13.48	0.	0.	82.

TOTAL INFLOW VOLUME	2551.	ACFT
TOTAL DISCHARGE VOLUME	2746.	ACFT
MAXIMUM WATER SURFACE ELEVATION	17.60	FT
MAXIMUM DISCHARGE THRU DIVERSION CONDUIT	223.	CFS
MAXIMUM TOTAL INFLOW	82.	CFS
MAXIMUM TOTAL DISCHARGE	236.	CFS

LAKE DEVOE DAM
REDO VOLUME - DISCHARGE CURVES
TO PROVIDE MORE POINTS NEAR TOP OF DAM

SHEET NO. 1 OF
JOB NO. 1209-001-1
BY KLB DATE 7-7-

	#	ELEVATION (FT)	Y2 VOLUME (AC-FT)	Y3 DISCHARGE (CFS)	Um HEAD ABOVE SPILLWAY (FT)
SPILLWAY CREST	1	17.6	0.	0.	0.
	2	18.7	25.	600.	1.10
	3	19.7	150.	1300.	2.10
	4	20.2	175.	1800.	2.60
TOP OF DAM	5	20.7	150.	2300.	3.10
	6	21.2	400.	3400.	3.60
	7	21.7	675.	4700.	4.10
	8	23.0	1375.	9500.	5.40
	9	26.0	2950.	24200.	8.40
	10	30.0	5100.	43000.	12.40

DATA FROM CURVES

Y=